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477423

A Method for Predicting Repair-Parts Replacement Developed from Data for M60 Tanks and M113 APCs (U)

by
John R. Bossenga
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Elizabeth C. Saip
Harry D. Sheets
Douglas E. Smith

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RAC

PREPARED FOR THE DEPARTMENT OF THE ARMY
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SUPPORT SYSTEMS DIVISION
TECHNICAL MEMORANDUM RAC-T-465
Published January 1966

A Method for Predicting Repair-Parts Replacement Developed from Data for M60 Tanks and M113 APCs (U)

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RESEARCH ANALYSIS CORPORATION
McLEAN, VIRGINIA

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DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

CRD/J

SUBJECT: RAC-T-465, "A Method for Predicting Repair-Parts Consumption Developed from Data for M60 Tanks and M113 APCs (U)"

TO:

1. Transmitted herewith is (are) __________ copy (copies) of RAC-T-465, subject as above.

2. RAC-T-465 was produced by the Research Analysis Corporation, McLean, Virginia, in conjunction with the contract study "Maintenance Support Requirements."

3. RAC-T-465 documents an investigation into the problem of forecasting repair parts requirements for important classes of Army equipment. The repair parts forecasting methodology described in this technical memorandum is based on the use of repair parts replacement data of the type now available through the Army Equipment Record System (TAERS). The study conclusions that demand data have not been a completely satisfactory basis for estimating future repair parts requirements and that the availability of consumption data through TAERS creates a significant possibility of using this data as an alternative or additional input in the decision-making process are considered valid. However, it is to be noted that the views expressed in RAC-T-465 are those of the Research Analysis Corporation and that the document is not an official Department of the Army publication.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

Incls
as

HERALD B. GALLINGER
Colonel, GS
Chief, Human Factors and
Operations Research Division

Received for Publication 28 April 1965
Published January 1966
by
RESEARCH ANALYSIS CORPORATION
McLean, Virginia

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FOREWORD

During the past 6 years ORO/RAC has undertaken comprehensive analyses of the operation, maintenance, and effective lifetimes of many important classes of Army equipment.* This series of investigations has led to the belief that a departure can be made from the Army's current practice of relying solely on historical demands for repair parts as the basis for determining stockage requirements. The repair-parts forecasting methodology described in this technical memorandum is based on the use of repair-parts replacement data of the type now available through The Army Equipment Record System (TAERS) and represents an approach that could lead to significant improvements in the computation of repair-parts requirements.

C. J. Christianson
Chief, Support Systems Division

*Operations Research Office (now RAC): "The Overhauling of Equipment," ORO-T-381, Aug 60. FOR OFFICIAL USE ONLY; "Operation, Maintenance, and Cost Experience of $\frac{1}{4}$-ton Truck Fleet (U)," ORO-T-382, May 61. CONFIDENTIAL; "Economics of Maintenance and Replacement of $\frac{3}{4}$-, $2\frac{1}{2}$-, and 5-ton Truck Fleets (U)," ORO-T-401, Sep 61. CONFIDENTIAL

Research Analysis Corporation (formerly ORO): "Materials-Handling Equipment: A Study of Economic Life," RAC(ORO)-T-406, Vol I, May 62, Vol II, Apr 62; "Operation, Maintenance, and Cost Experience of the Tank, Armored Personnel Carrier, and Self-Propelled Howitzer Vehicle Fleets (U)." RAC(ORO)-T-409, Sep 62. SECRET; "Allocation of Maintenance and Support Resources for Tactical Communications Equipment," RAC-T-413, Sep 63. FOR OFFICIAL USE ONLY; "Operation and Maintenance Experience of the Heavy and Medium Tractors (Crawler), 20-ton Crane, Road Grader, 1.5-kw Generator, and 45-kw 400-cps Generator," RAC-T-428, Aug 64. FOR OFFICIAL USE ONLY; "Operation, Maintenance, and Lifetimes of M60 Tanks, M113 Armored Personnel Carriers, and M88 Recovery Vehicles (U)," RAC-T-460. Mar 65. CONFIDENTIAL

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The interest of Mr. F. Coopes, Secondary Items Division, Supply Directorate, US Army Tank Automotive Center (ATAC); Mr. E. Slayman, Maintenance and Reliability Division, Maintenance Directorate, ATAC; and Mr. J. McCallister, Special Purpose Vehicle Division, Maintenance Directorate, ATAC, is also appreciated.

Many members of RAC's Support Systems Division contributed to this study. The efforts of the following individuals are particularly important: Messrs. Richard G. Huver and Jerry L. Buffay, who helped to collect and analyze much of the M60 tank and M113 APC data; Mrs. Virginia S. Ellis, who assisted in analyzing replacement-rate data and in preparing the tables in Apps A to E; and Mrs. Thelma A. Chesley, who provided numerous technical contributions and prepared the draft manuscript for publication.

The authors especially wish to thank two members of the RAC Computer Sciences Center: Mr. Fred C. Hipp, who made several helpful suggestions concerning the mathematical formulations used in estimating repair-parts consumption, and Mrs. Sandra A. Veit, who programmed and provided written descriptions of the Expected Number of Repair Parts Actions Routine and the End Item Inventory Usage Routine.

The RAC Murder Board, composed of Gen Thomas T. Handy, Chairman, Dr. Richard M. Soland, and Gen N. M. Lynde, offered many constructive suggestions, which improved the pertinence and quality of the document.

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Figures

Tables

ERRATA, RAC-T-465

P 26, Table 16, col 8. *For:* "7 = 2 × 5 × 6"
Read: "(8 = 3 × 6 × 7)"

P 27, l 9. *For:* "col 7"
Read: "col 8"

P 29, last para. *For:* "during the period from the third quarter of 1964 to the fourth quarter"
Read: "during the four quarters"

P 55, Table B10. *For:* "On Starter Relays"
Read: "For Starter Relays"

SUMMARY

Problem

To develop a method for predicting the replacement of repair parts (assemblies, subassemblies, and components) based on replacement rates obtained from an analysis of maintenance-action data.

Facts

The Support Systems Division of RAC is currently studying a variety of Army problems involving materiel readiness. One of these studies, RAC-RP-162.1, "Maintenance Support Requirements," is analyzing techniques for the improvement of repair-parts forecasting. At the request of the study's Project Advisory Group, special consideration is being given to the possibility of using data from TAERS. Because TAERS data of the type desired were not available to the project during the research described in this technical memorandum, USAREUR data collected for M60 tanks and M113 APCs by Support Systems personnel[1] were used to develop the forecasting methodology.

Discussion

The availability of repair parts continues to be one of the most important factors affecting the materiel-readiness posture of the US Army.[2,3] A repair part is defined as any part, subassembly, assembly, or component required for installation in the maintenance or repair of an end item, subassembly, or component.[4]

After a new end item of equipment has been introduced into the inventory and the period of initial provisioning has passed, repair-parts procurement decisions are based on the quantity of parts requisitioned (demanded). However, the number of repair parts demanded may be an unreliable measure of future repair-parts requirements. TAERS is designed to provide parts-consumption information, i.e., data showing the use of parts in a current repair or replacement action. These consumption data provide another type of information for consideration in determining repair-parts replenishment actions for many end items of Army equipment.

This technical memorandum describes a method of estimating repair-parts consumption for vehicle fleets during periods of projected future utilization. At the request of the study's Project Advisory Group and interested

SUMMARY

Army agencies, the methodology developed is capable of using TAERS-type information as input data, and calculating repair-part consumption estimates automatically through the use of a series of computer routines.

The methodology developed is summarized in Table 1. For any repair parts of interest the first step involves the calculation of replacement rates during individual usage intervals as, for example, each 100 miles of operation.

TABLE 1

Summary of Forecasting Methodology

Step	Description	Computer routine(s) used
1	Determining usage-dependent rates of repair-part replacement	Events rates
2	Projecting these rates into future time periods	Least squares
3	Combining projections of replacement rates and end-item usage distributions to estimate the number of repair parts replaced	End item inventory usage Expected number of repair parts actions

This step of the estimation process is described in detail in Chap. 2, and the associated computer routine is described in Apps A and B. The second step employs standard statistical techniques to provide a means of projecting the usage-dependent replacement rates into the time period under study (see Chap. 3 and App C). In the final step the projected replacement rates are combined with projections of vehicle usage to develop estimates of the number of repair parts that will be replaced during the time period studied. Detailed information for this step is presented in Chap. 4 and App D.

Conclusions

This methodology can be useful in estimating repair-parts consumption throughout the period of utilization of many different end items of equipment for which TAERS data are available. The value of the forecasts obtained, however, depends directly on the accuracy and completeness of the input data utilized.

Recommendation

The proposed methodology should be tested on a selected sample of repair parts for a given end item and organization to determine how closely repair-parts replacement forecasts developed by applying this methodology correspond to actual quantities of parts replaced.

A Method
for Predicting Repair-Parts Replacement
Developed from Data
for M60 Tanks and M113 APCs

Chapter 1

INTRODUCTION

One of the most important factors affecting combat readiness is the availability of repair parts. Commanders' statements in the materiel-readiness reports[2] and the findings of the Baker Board of Inquiry on materiel readiness[3] indicate that the readiness of many combat units is being adversely affected by a lack of repair parts. The availability of repair parts depends on the ability of the supply system to (a) determine how much of what materiel should be put into the supply bin and its ability (b) to move the materiel from bin to user as quickly as possible when it is needed.

RAC-TP-158[5] described the ability of the Seventh Army supply system to perform the second function. It was found that when requisitions from combat units were filled at Seventh Army level, 18 days was required to fill 50 percent of the demands, 29 days to fill 75 percent. Significant steps are being taken to improve this performance. For the short term, Seventh Army is investigating order and shipping time with the assistance of a special team from Army Materiel Command. The long-term approach is exemplified by a Supply and Maintenance Command proposal that RAC undertake a comprehensive study of the total supply system.

The other function of the supply system, that of estimating repair-parts requirements, is complex and characterized by imprecision. The result is a tendency toward simultaneous feast and famine in various sectors of repair-parts supply operations. For example, RAC-TP-158[5] showed the supply position of the 23 direct support supply activities (DSSAs) supporting five divisions and three cavalry regiments in US Seventh Army during a 3-month period in the summer of 1964. Of the total number of line items included on the stockage lists of these DSSAs, 32 percent were in zero balance, i.e., out of stock. At the same time there were significant excesses of secondary items in the worldwide Army inventory,[6] as shown in Table 2. For all secondary items (a large portion of which are repair parts[7]) held at storage sites, excesses at the end of FY64 represented 18 percent of the total dollar value of stocks in inventory. For the dollar value of Mobility Command inventory alone (of which more than half are tank and automotive secondary items) excesses represented 26 percent of total inventory values.

These findings highlight the long-recognized fact that improvements in repair-parts forecasting techniques could result in improved parts availability, fewer excesses, and a higher state of readiness.

TABLE 2

Value of Worldwide US Army Secondary Stocks in Excess[6]

(1 January to 30 June 1964)

Source of appropriation	All secondary items			Mobility Command secondary items		
	Total stocks	Excess stocks	Excess, %	Total stocks	Excess stocks	Excess, %
	Thous of dollars			Thous of dollars		
PEMA[a] and O&MA[b]	1,191,595	182,211	15	573,894	120,637	21
Stock funded	2,002,416	408,344	20	767,470	233,882	30
Totals	3,194,011	590,555	18	1,341,364	354,519	26

[a]Procurement of equipment and missiles, Army.
[b]Operations and maintenance, Army.

Under the present system of forecasting repair-parts requirements the commodity analyst follows procedures outlined in AR 710-45.[4] For newly issued end items that have not previously been in the supply system, engineering-type estimates are used as the basis for determining the initial provisioning and stockage of repair parts. However, for ongoing items that have been in the system for some time an analysis of present and alternative techniques may result in improved forecasting of parts requirements.

Two general types of data can be used as the basis for estimating future repair-parts needs.

Demand data originate in the supply system and represent requisitions for repair parts to meet present or expected future needs. Although demand data do not necessarily reflect the actual use of the parts in current maintenance activity, they are the basis of the current technique used for forecasting repair-parts requirements for end items that have been in the supply system for some time. Figure 1 is a sample of DA Form 1794 "Supply Control Study" now filled out by commodity analysts for all high-dollar and superhigh-dollar items. This form and AR 710-45,[4] which describes its use, demonstrate both the complexity of the present estimating procedure and the fact that under the present system purchasing for the future is done on the basis of recent demand patterns.

Consumption data are obtained from records of maintenance actions and represent the use of parts in a current repair or replacement maintenance action. Since the word "consumption" as used in this context refers to the replacement of both reparable and nonreparable items, the terms "consumption data" and "replacement data" are used interchangeably in this report. Data of this type are now available in TAERS. This system of record-keeping should facilitate rapid transmission and machine processing of repair-parts-action records. The basic objective of TAERS is to retain only the minimum number of forms for recording and transmitting essential information, and at the same time to include all Army equipment for which records and maintenance data are required for control and planning. Most of these records are of maintenance

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SUPPLY CONTROL STUDY MINOR SECONDARY ITEMS AND REPAIR PARTS (AR 710-45)

1 PREPARING AGENCY | 2 STOCK NUMBER | 3 ITEM DESCRIPTION | 4 DATE OF STUDIES: LAST, CURRENT

5 APPLICATION | 6 SUBSTITUTES | 7 ITEM TYPE | 8 RECOVERABILITY | 9 STOCK STATUS CUT-OFF DATE: USARPAC, USAREUR, CONUS

10 UNIT COST | 11 FIA CATEGORY | 12 FUND CODE | 13 UNIT ISSUE | 14 UNIT PACK | 15 TYPE CLAS | 16 ITEM IN SYSTEM (Months) | 17 ESSENTIALITY | 18 REORDER POINTS: LAST, CURRENT

19 REPAIR CYCLE (Months): ACT, ALT, RLT, OLT | 20 PROC LEAD TIME (Months): ALT, PLT, OLT | 21 REORDER CYCLE (Months) | 22 BPTFHR (Months) | 23 OPERATING LEVEL (Months) | 24 REASON FOR STUDY

ELEMENTS OF SUPPLY CONTROL: A HISTORICAL AND PREDICTION DATA; B DEMAND AND ASSET DATA. FORECASTS: C, D, E, F, G, H, I (BAL __ QTR FY __ MOS; __ QTR FY __ MOS)

SECTION I USARPAC: 1 AQD; 2 AQR - SERVICEABLE; 3 AQR - REPAIRABLE; 5 BASE PERIOD; 6 PROGRAM DATA: FY, 1ST QTR, 2D QTR, 3D QTR, 4TH QTR. PROGRAM CHANGE FACTORS; RECURRING DEMANDS; ENROUTE AND BELOW DEPOT P/L CHANGES (Days); NONRECURRING DEMANDS; SAFETY LEVEL AND CHANGES; TOTAL DEMANDS; SERVICEABLE RETURNS (Ratio); REPAIRABLE RETURNS (Ratio); TOTAL ASSETS; 11 NET USARPAC DEMANDS ON CONUS

SECTION II USAREUR: 12 AQD; 13 AQR - SERVICEABLE; 14 AQR - REPAIRABLE; 16 BASE PERIOD; 17 PROGRAM DATA: FY, 1ST QTR, 2D QTR, 3D QTR, 4TH QTR. PROGRAM CHANGE FACTORS; RECURRING DEMANDS; ENROUTE AND BELOW DEPOT P/L CHANGES (Days); NONRECURRING DEMANDS; SAFETY LEVEL AND CHANGES; TOTAL DEMANDS; SERVICEABLE RETURNS (Ratio); REPAIRABLE RETURNS (Ratio); TOTAL ASSETS; 22 NET USAREUR DEMAND ON CONUS

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SECTION IV PTFHR ON CONUS: 31 SUM OF NET DEMANDS ON CONUS DEPOTS (Sum of lines 11, 22 and 30); 32 CONUS SAFETY LEVEL CHANGES (Type:) (SL qty); 33 NONRECURRING DEMANDS (Non-Army); 36 TOTAL DEMANDS ON CONUS DEPOTS (Sum of lines 31 thru 35)

SECTION V GAINS FROM RETURNS: 37 AQR - REPAIRABLE FORECAST (AQR) (Ratio); 38 GAINS FROM FORECASTED REPAIR (Apply repair cycle block 19); 39 GAINS FROM UNSCHEDULED REPAIR (Apply repair cycle block 19); 40 GAINS FROM SCHEDULED REPAIR; 41 AQR - SERVICEABLE RETURNS (AQR) (Ratio); 42 TOTAL GAINS FROM RETURNS (Sum of lines 38 thru 41)

SECTION VI PROCUREMENT SCHEDULE: 43 PROC DIRECT | PROC DIRECT DATE | CONTRACT DATE | DATE FIRST DELIVERY | BALANCE DUE IN; 48 TOTAL DUE IN FROM PROCUREMENT

SECTION VII SUPPLY CONTROL ACTIONS: DURING PTFHR: 49 APPLY ASSETS TO: DO + RO + BAL PTFHR — DO — RO = PMRMO + SL + PROLT + REOCY; 50 PTFHR SUPPLY STATUS | RQR AND ASSETS | DUES OUT | PMRMO: CONUS, O/S | SL; 51 GROSS REQUIREMENT (DO + RO); 52 SERVICEABLE STOCKS; 53 GAINS FROM RETURNS (From line 42); 54 DUE IN FROM PROCUREMENT (From line 48); 55 TOTAL ASSETS; 56 SUPPLY POSITION (±) (Cumulative line 51 minus 55); 57–60 PROPOSED ACTIONS. BEYOND PTFHR: 61 BEYOND PTFHR SUPPLY STATUS | AUTH AND ASSETS | BMRMO | ECON RET | MAP RET | EXCESS; 62 AUTHORIZED LEVELS; 63 ASSETS (Available from lines 57 thru 60); 64 SUPPLY POSITION (±) (Cumulative line 62 minus 63); 65–66 PROPOSED ACTIONS

SECTION VIII - FIA LEVELS: PMRMO, SL, PROLT, REOCY, BPTFHR, BMRMO; ECON RET, MAP RET, TOTAL

SECTION IX - REMARKS (Continue on reverse if necessary)

SECTION X REVIEW AND APPROVAL: 67 COMPUTED BY | ORG CODE | DATE | LAST PROCUREMENT: DATE, VALUE; 68 REVIEWED BY | CURRENT ACTIONS APPROVED: PROCUREMENT $, REPAIR $; 69 APPROVED BY | OTHER $; 70 APPROVED BY

DA FORM 1 SEP 62 1794 REPLACES DA FORMS 1794, 1794-1, 1794-2, 1794-3, AND 1794-4, 1 JUL 60, WHICH ARE OBSOLETE.

Fig. 1—Form Used by Commodity Analysts in Preparing Supply Control Studies

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actions (adjustment, repair, or replacement) at unit and field level and therefore constitute a source of parts-consumption data.

In an ideally responsive supply system, demand data and consumption data would be nearly identical. If every parts user could be assured of obtaining all the repair parts he needed at a few moments' notice and if all echelons of supply activity could promptly replenish their supplies from a higher echelon, demand and consumption data would represent two sides of the same coin and would therefore be equally reliable bases for parts-requirements forecasting.

For a number of reasons these ideal conditions do not exist. Perturbations and delays in the supply system are caused by geographic distance, procurement lead times, financial restrictions, personnel turbulence, and technological improvement of end items with resultant multiplication of the number and complexity of pertinent repair parts. Further, the orderly demand pattern may be distorted as requisitions are passed upward through the various echelons of supply. AR 710-45,[4] which prescribes the procedure to be followed in preparing supply control studies, specifically cautions the commodity analyst:

> The demands from units, geographically separated and having different activities, flow through multi-echelons. These echelons, by the addition of safety levels and the imposition of varying degrees of time delay (order and ship time, operating levels, etc., are all forms of time delay), distort and amplify the original frequency distribution of demand into many shapes and patterns. Forecasting, then, is based on skillful handling and understanding of data and the projection of that data into the future.[4]

These difficulties were further elaborated in a report submitted by Frankford Arsenal:[8]

> The requisitions that are used as a basis for forecasting the expected demand at a stockage point are themselves composed in large measure of forecasts of expected demand that have been made by the stockage point's customers. These data can, then, be expected to be very different from the actual failure data or true parts consumption data. They are, however, the data on which inventory management decisions are made, frequently without appreciation of the fact that, while termed "demands" they are really forecasts that are superimposed on other forecasts. Thus, a National Inventory Control Point forecast of future system demand that uses past demand history as a basis for projection is in reality a projection of many lower level forecasts. It should come as no surprise, then, that the demand history exhibits such characteristically erratic patterns.[8]

For these reasons demand data have not been a completely satisfactory basis for estimating future repair-parts requirements. The availability of consumption data through TAERS creates the significant possibility of using these data as an alternative or additional input in the decision-making process.

This technical memorandum is devoted to an analysis of how consumption data can be utilized in forecasting repair-parts requirements. At the time this research was conducted, TAERS equipment-history data tapes were not available for study by RAC analysts. To develop forecasting techniques tailored to TAERS-type information, RAC data for M60 tanks and M113 APCs were used. These data were collected from USAREUR organization- and field-level maintenance records by teams of RAC analysts who visited USAREUR on four occasions between February 1962 and September 1963. The 3d and 4th Armd Divs were the principal sources of M60 tank data. The 24th Inf (Mech) Div and the 3d Armd Div were the primary sources of M113 APC information. Summaries by battalion of the vehicles studied are presented in Tables 3 and 4.

TABLE 3

Usage of USAREUR M60 Tanks in RAC Sample

Unit	Vehicles	Average months in service	Average miles per month	Average total mileage
3d Armd Div	250	23	142	3264
3d Bn, 33d Armor	54	23	124	2859
3d Bn, 12th Armd Cav Regt	31	19	179	3406
2d Bn, 32d Armor	66	22	137	3024
1st Bn, 33d Armor	77	24	161	3856
2d Bn, 33d Armor	22	23	117	2702
4th Armd Div	323	20	115	2305
2d Bn, 15th Armd Cav Regt	20	20	124	2473
24th Engr Bn	7	6	145	870
2d Bn, 35th Armor	55	21	112	2347
1st Bn, 37th Armor	55	20	120	2391
3d Bn, 37th Armor	48	20	124	2485
2d Bn, 37th Armor	56	21	118	2472
4th Bn, 35th Armor	72	21	103	2173
Special training vehicles	10	15	96	1434
24th Inf Div	67	22	131	2871
1st Bn, 70th Armor	33	22	127	2792
2d Bn, 70th Armor	34	22	134	2947
Total	640	21	130	2739

TABLE 4

Usage of USAREUR M113 APCs in RAC Sample

Unit	Vehicles	Average months in service	Average miles per month	Average total mileage
24th Inf Div	357	18	164	2945
3d Bde	7	14	173	2418
1st Bn, 19th Inf	68	18	132	2382
1st Bn, 21st Inf	82	18	157	2830
2d Bn, 21st Inf	72	17	174	2957
1st Bn, 34th Inf	31	18	158	2840
3d Bn, 19th Inf	78	21	174	3656
2d Bn, 34th Inf	19	20	139	2772
3d Armd Div	185	18	155	2796
3d Bn, 33d Armor	14	14	108	1506
1st Bn, 33d Armor	17	14	129	1806
3d Bn, 36th Inf	61	20	155	3097
1st Bn, 48th Inf	27	19	189	3583
2d Bn, 48th Inf	66	16	170	2726
4th Armd Div				
51st Inf	63	14	111	1557
2d Armd Cav Regt	64	17	116	1964
1st Bn, 2d Armd Cav Regt	20	17	128	2184
2d Bn, 2d Armd Cav Regt	23	18	110	1973
3d Bn, 2d Armd Cav Regt	21	16	109	1744
14th Armd Cav Regt	38	22	100	2206
1st Bn, 14th Armd Cav Regt	19	23	98	2265
2d Bn, 14th Armd Cav Regt	19	20	107	2147
Total	707	18	147	2654

The main sources of data are summarized in Table 5. A detailed discussion of the information obtained from these sources is presented in RAC-T-460.[1]

TABLE 5

Main Sources of Data Collected

DA form	Information extracted
2408-1	Daily vehicle record of miles and/or hours operated; fuel and oil consumed; month-by-month summary of vehicle operation
2408-3-1	Repair parts replaced, repaired, and adjusted by organizational (second-echelon) personnel
2408-6	Field maintenance (third-echelon) repair and parts replacement
2408-7	Issue date of vehicle to unit; transfer date of vehicle from unit
2407	Requests by organizational units for field maintenance services, repairs, and modification work orders

Chapter 2

DEVELOPMENT OF REPLACEMENT RATES

SIGNIFICANCE OF TIME-DEPENDENT FAILURE RATES

Consumption data can be utilized to project parts requirements in a number of ways. One of the simplest is calculating a replacement factor for the part in question. This factor represents number of replacements per vehicle/period of observation. The period observed may be expressed in such terms as months, miles, rounds fired, or landings made. For example, if consumption data showed that an average of 0.30 M60-tank-engine replacements were made per tank during a given 12-month period, the replacement factor would be 0.30 replacement/12 months or 0.025 per month. A simple projection of these data could then be made as follows:

$$\begin{matrix}\text{Replacement factor} \\ \text{of part}\end{matrix} \times \begin{matrix}\text{number of vehicles} \\ \text{using the part}\end{matrix} \times \begin{matrix}\text{time period} \\ \text{studied}\end{matrix} = \begin{matrix}\text{parts} \\ \text{required}\end{matrix}$$

If the hypothetical M60-tank-engine replacement factor were projected for a fleet of 2000 tanks for a 2-year period of use, the number of engines replaced would be

$$0.30/12 \times 2000 \text{ tanks} \times 24 \text{ months} = 1200 \text{ engines.}$$

The replacement factor of a part may also be expressed as its mean life by simply inverting the fraction. In the example given above the replacement factor 0.30 replacement/12 months becomes 12 months/0.30 replacement, or a mean life of 40 months. This mean life may then be used to calculate requirements for a 24-month period as follows:

$$(2000 \text{ tanks} \times 24 \text{ months}) \div \begin{matrix}40 \text{ months mean life} \\ \text{per tank engine}\end{matrix} = 1200 \text{ engines.}$$

For parts that experience a constant replacement factor regardless of age or utilization this type of projection is accurate. However, if the replacement factor of a part increases as the vehicle ages in time or use, procurement based on this method of forecasting could fall seriously short of the needs that actually exist at the time the parts are received from the manufacturer.

This problem can be illustrated by an analysis, shown in Fig. 2, of the failure experience of M60 tank generators in USAREUR. In this figure mathematical techniques described in Chap. 3 are used to translate individual

replacement factors (represented by dots) into a "curve" for the entire mileage range. From this curve it can be seen that at 1000 miles the replacement factor is 0.007, or 7 generators per 1000 vehicles per 100 miles. By 3000 miles this replacement has increased to 0.009, or 9 generators per 1000 vehicles per 100 miles, an increase of nearly 30 percent.

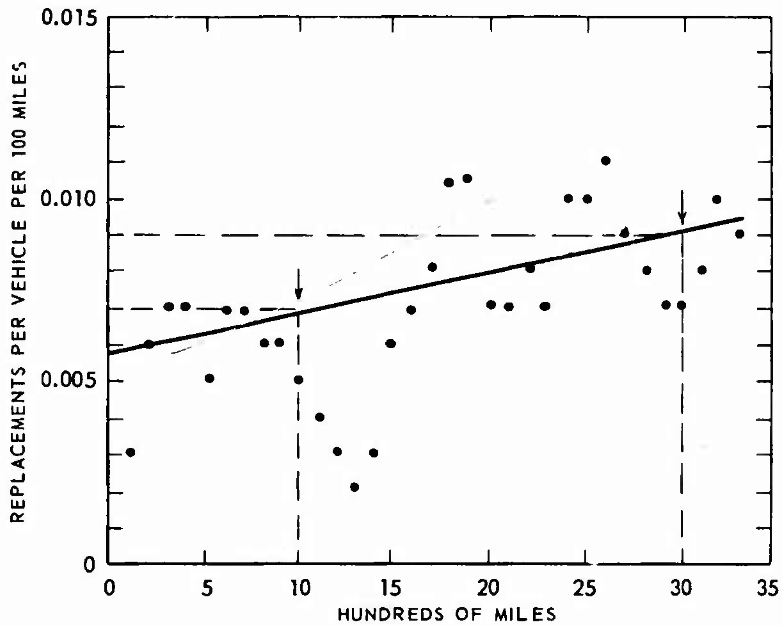


Fig. 2—Replacement Factors for USAREUR M60 Tank Generators

Delays in the procurement and delivery of repair parts (administrative lead time, production lead time, and delivery lead time) are recognized factors in the management of parts supply. When these delays are accompanied by an age- or use-dependent failure rate for the repair part in question, sensitive forecasting of future requirements will require the answers to two major questions:

(a) What is the pattern of replacement frequency as the vehicle ages in time or use?

(b) What will be the age and/or mileage distribution of the fleet by the time the parts actually enter the supply system?

Methods of determining the answer to question a constitute the major subject matter of this chapter. Question b is discussed in Chap. 4.

COMPUTATION OF TIME-DEPENDENT REPLACEMENT RATES

The IBM 7040 computer routine described in detail in App A was used to compute the parts-replacement rates used in this study. The method used may be expressed as the fraction

$$\frac{\text{Number of replacements}}{\text{number of vehicles available to experience replacement}} = \text{replacement rate of repair part}$$

In this analysis the primary usage measure was that of mileage traveled; any pertinent measure of utilization (e.g., months, rounds fired, operating hours, or landings) could be used.

The basic information used in computing these failure rates is shown in two types of tables: the events table for the numerator of the rate fraction and the vehicle-sample density table for the denominator. An illustrative example of each is discussed below. This discussion and Tables 6 to 11 are based on a hypothetical fleet of 640 vehicles that experience replacements of repair part X.

Events Table

Table 6 shows a hypothetical example of an events table for repair part X. Usage intervals are delineated in hundreds of miles. The columns for first, second, and third order of replacement indicate whether part X is being replaced for the first, second, or third time. The numbers appearing in these columns therefore indicate how many replacements occurred at what mileage and what order of replacement each was.

TABLE 6

Hypothetical Example of Events Table: Replacements of Repair Part X

Usage interval, miles (1)	Order of replacements			
	1st (2)	2d (3)	3d (4)	Total (5)
0–100	2	0	0	2
101–200	6	0	0	6
201–300	5	0	0	5
301–400	12	1	0	13
401–500	16	3	0	19
501–600	28	4	0	32
601–700	27	7	2	36
701–800	32	6	1	39
801–900	42	9	1	52
901–1000	50	10	2	62

This table could also have been based on the number of maintenance actions instead of the number of parts replaced. For some types of studies (for example, those dealing with vehicle reliability) frequency of maintenance activity is of greater interest than the number of parts utilized. An events table showing number of job orders would be an important input for such an analysis.

Vehicle-Sample Density Table

The denominator of the replacement-rate fraction is the number of vehicles eligible to experience replacement. This denominator is not always the

same as the total number of vehicles in the sample fleet; two forces operate to reduce it at higher usage intervals.

(a) When a vehicle experiences a first replacement of part X in the 0–100 mile interval, it cannot experience a first replacement of this part at any higher mileage. This fact is demonstrated in Table 7, using the replacement distribution shown in Table 6. Table 7 assumes that all 640 vehicles in the observed

TABLE 7

Decrease in Vehicles Eligible To Experience First Replacement of Part X: Because First Replacement Has Already Occurred

Usage interval, miles	Number of first-order replacements during usage interval	Number of vehicles that have not yet experienced first-order failures at beginning of usage interval	Cumulative decrease in number eligible for first-order failures at beginning of usage interval
0–100	2	640	0
101–200	6	638	2
201–300	5	632	8
301–400	12	627	13
401–500	16	615	25
501–600	28	599	41
601–700	27	571	69
701–800	32	544	96
801–900	42	512	128
901–1000	50	470	170

fleet travel at least 1000 miles. Since two vehicles have first replacements of part X during the first 100 miles, the table shows that only 638 of the 640 could experience first replacements between 101 and 200 miles. Another six have first replacements of this part between 101 and 200 miles; only 632 could therefore experience first replacements between 201 and 300 miles. By the 901 to 1000-mile usage interval only 470 vehicles out of a total fleet of 640 are eligible to experience first replacements of part X since 170 have already done so at earlier mileages.

(b) Even if there had been no replacements of part X up to 1000 miles, the number of vehicles available for observation at that mileage would still be less than the original 640 because some vehicles would not have traveled that far (see Table 8). In most vehicle samples all vehicles have not traveled the same number of miles; at the higher mileages the vehicle sample is therefore smaller than at the lower mileages. Table 8 illustrates the effect of this factor on vehicle-sample density. In this example all 640 vehicles had traveled at least 301 miles. One vehicle, however, had traveled more than 301 but less than 400 miles; the sample therefore dropped to 639 for the 301–400-mile usage interval. Only 634 out of 640 vehicles had traveled at least 901 miles, a decrease of six in the number of vehicles available for observation.

Table 9 combines selected portions of Tables 7 and 8 to show how the two forces described above combine to affect the number of vehicles eligible to experience a first replacement of part X at various mileage intervals. Column 2

TABLE 8

Decrease in Vehicles Available To Experience First Replacement of Part X: Because Mileage Accumulation Is Insufficient

Usage interval, miles	Vehicles with last observed mileage occurring during usage interval	Vehicles observed that have traveled this mileage or more	Cumulative decrease in sample size
0–100	0	640	0
101–200	0	640	0
201–300	0	640	0
301–400	1	639	1
401–500	0	639	1
501–600	1	638	2
601–700	2	636	4
701–800	0	636	4
801–900	1	635	5
901–1000	1	634	6

TABLE 9

Decrease in Vehicles Eligible To Experience First Replacement of Part X: Because First Replacement Has Already Occurred or Mileage Accumulation Is Insufficient

Usage interval, miles	Cumulative decrease in vehicles eligible to experience first-order replacement			Vehicles eligible to experience first replacement, 640 − (3), $R_{s/e}$ denominator	Vehicles observed and available to experience replacement, 640 − (2), $R_{a/o}$ denominator
	Because vehicle has experienced first replacement in preceding usage intervals	Because of insufficient mileage	Total		
(1)	(2)	(3)	(4)	(5)	(6)
0–100	0	0	0	640	640
101–200	2	0	2	638	640
201–300	8	0	8	632	640
301–400	13	1	14	626	639
401–500	25	1	26	614	639
501–600	41	2	43	597	638
601–700	69	4	73	567	636
701–800	96	4	100	540	636
801–900	128	5	133	507	635
901–1000	170	6	176	464	634

shows the loss to the sample because first replacement of the part has already occurred; col 3 shows the loss because of insufficient accumulation of mileage. Column 4 is the total of the preceding two and represents the total decrease in the number of vehicles eligible for both reasons. In the actual computational technique, any given vehicle is dropped from the "eligible to experience first-order replacement" category for either of these two reasons, whichever occurs first.

Columns 5 and 6 represent two possible denominators that could be used in calculating replacement rates. Two major types of replacement-rate calculations are discussed in this chapter; for any given usage interval either type

of rate can be computed. The distinction between these two types of replacement rates is an important one and can best be remembered in terms of the letters in the subscripts.

$R_{s/e}$ is a replacement rate based on a specific order of replacement (first, second, or third, etc.). In the subscript the numerator s stands for the specific order of replacement; the denominator e refers to the number of vehicles eligible to experience this given order of replacement during the specified usage interval.

$R_{a/o}$ is a replacement rate based on all orders of replacement combined. In this case the subscript numerator a stands for all orders of replacement; the denominator o refers to the number of vehicles observed at each mileage interval.

Column 5 shows the number of vehicles eligible to experience a first replacement of part X at various mileages. It is an $R_{s/e}$ denominator and represents 640 vehicles minus the decrease in sample size for the reasons illustrated in Tables 7 and 8. By the 901–1000-mile interval 176 vehicles had dropped out of the sample: 170 vehicles because they had already experienced first failures, and 6 because they had not accumulated sufficient mileage. The number still eligible to experience a first replacement is therefore 464 vehicles: 640 minus 6 minus 170. Column 6 shows the number of vehicles available to experience a replacement of part X regardless of replacement order. It is an $R_{a/o}$ denominator and represents 640 vehicles minus the number of vehicles that have dropped out of the sample because of insufficient mileage. By the 901–1000-mile interval this number is 640 minus 6, or 634 vehicles.

By combining the information in Tables 6 and 8 according to the procedure illustrated in Table 9 it is possible to prepare a vehicle-sample density table showing the denominators to be used in replacement-rate calculations. Table 10 shows a hypothetical example of such a table for repair part X. Columns 2, 3, and 4 represent $R_{s/e}$ denominators for first-, second-, and third-order replacements of part X. Column 5 is the $R_{a/o}$ denominator for the same fleet.

The calculation of replacement rates is then a matter of dividing the replacement-events data shown in Table 6 by the vehicle-sample density data in Table 10. Examples of the two major types of calculations are given below.

$R_{s/e}$ Rate for a Specific Order of Replacement. The replacement rate for first-order replacements of part X for the mileage range 701–800 miles is obtained by determining

$$\frac{\text{Number of first replacements, 701–800-mile interval}}{\text{number of vehicles that have not yet experienced first replacement, 701–800-mile interval}} = \frac{\text{col 2, Table 6}}{\text{col 2, Table 10}} = \frac{32}{540} = 0.0593$$

$R_{a/o}$ Rate for All Orders of Replacement Combined. The replacement rate for all orders or replacement of part X for the mileage range 701–800 miles is obtained by determining

$$\frac{\text{Number of replacements of all orders, 701–800-mile interval}}{\text{number of vehicles observed and available to experience any order of replacement, 701–800-mile interval}} = \frac{\text{col 5, Table 6}}{\text{col 5, Table 10}} = \frac{39}{636} = 0.0613$$

Table 11 shows the results of $R_{s/e}$ and $R_{a/o}$ replacement-rate calculations for part X for various mileage intervals. Each rate shown in Table 11 represents the division of the replacement-events data from Table 6 by the corresponding vehicle density from Table 10.

TABLE 10

Hypothetical Example of Vehicle Sample Density Table: Vehicles Available for Replacements

Usage interval, miles	Vehicles that have not yet experienced specific-order replacement, $R_{s/e}$ denominators			Vehicles observed and available for replacements, $R_{a/o}$ denominator
	1st	2d	3d	
(1)	(2)	(3)	(4)	(5)
0–100	640	640	640	64[illegible]
101–200	638	640	640	[illegible]
201–300	632	640	640	640
301–400	626	639	639	63[illegible]
401–500	614	638	639	[illegible]
501–600	597	634	638	638
601–700	567	628	636	636
701–800	540	621	634	636
801–900	507	614	632	635
901–1000	464	604	630	634

TABLE 11

$R_{s/e}$ and $R_{a/o}$ Replacement Rates for Part X

Usage interval, miles	$R_{s/e}$			$R_{a/o}$
	1st	2d	3d	
(1)	(2)	(3)	(4)	(5)
0–100	0.0031	0.0000	0.0000	0.0031
101–200	0.0094	0.0000	0.0000	0.0094
201–300	0.0079	0.0000	0.0000	0.0078[a]
301–400	0.0192	0.0016	0.0000	0.0203
401–500	0.0261	0.0047	0.0000	0.0297
501–600	0.0469	0.0063	0.0000	0.0502
601–700	0.0476	0.0111	0.0031	0.0566
701–800	0.0593	0.0097	0.0016	0.0613
801–900	0.0828	0.0147	0.0016	0.0819[a]
901–1000	0.1078	0.0166	0.0032	0.0978[a]

[a]The $R_{a/o}$ replacement rate (for all orders of replacement) may be slightly lower than the $R_{s/e}$ rate (for a specific order of replacement) because the two rates have different denominators as well as numerators.

TABLE 12

Occurrence of Replacements, Available Vehicles, and $R_{s/e}$ and $R_{a/o}$ Replacement Rates for USAREUR M60 Tank Engines, by Mileage Interval

Usage interval, miles	Replacements				Vehicles that have not yet experienced these replacements				Vehicles available to experience replacement	$R_{s/e}$				$R_{a/o}$
	1st	2d	3d	4th	1st	2d	3d	4th		1st	2d	3d	4th	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
0–100	2	0	0	0	639.0	639.0	639.0	639.0	639.0	0.003	0.	0.	0.	0.003
101–200	2	0	0	0	635.7	639.0	639.0	639.0	639.0	0.003	0.	0.	0.	0.003
201–300	4	0	0	0	632.2	638.0	638.0	638.0	638.0	0.006	0.	0.	0.	0.006
301–400	4	1	0	0	627.7	636.8	637.0	637.0	637.0	0.006	0.002	0.	0.	0.008
401–500	3	1	0	0	623.0	633.5	634.6	634.6	634.6	0.005	0.002	0.	0.	0.006
501–600	7	0	0	0	616.2	632.0	634.0	634.0	634.0	0.011	0.	0.	0.	0.011
601–700	1	0	0	0	611.1	630.9	632.9	632.9	632.9	0.002	0.	0.	0.	0.002
701–800	4	0	0	0	606.7	629.0	631.0	631.0	631.0	0.007	0.	0.	0.	0.006
801–900	3	0	0	0	601.1	628.0	630.0	630.0	630.0	0.005	0.	0.	0.	0.005
901–1000	5	0	0	0	598.0	628.0	630.0	630.0	630.0	0.008	0.	0.	0.	0.008
1001–1100	4	0	0	0	591.9	626.8	628.8	628.8	628.8	0.007	0.	0.	0.	0.006
1101–1200	1	0	0	0	589.3	626.0	628.0	628.0	628.0	0.002	0.	0.	0.	0.002
1201–1300	5	0	0	0	583.1	623.9	625.9	625.9	625.9	0.009	0.	0.	0.	0.008
1301–1400	6	1	0	0	573.7	619.4	621.7	621.7	621.7	0.010	0.002	0.	0.	0.011
1401–1500	8	0	0	0	564.4	616.2	619.2	619.2	619.2	0.014	0.	0.	0.	0.013
1501–1600	9	2	0	0	553.4	610.3	614.6	614.6	614.6	0.016	0.003	0.	0.	0.018
1601–1700	15	2	0	0	538.6	603.0	608.7	608.7	608.7	0.028	0.003	0.	0.	0.028
1701–1800	10	1	0	0	510.1	594.7	602.6	602.6	602.6	0.019	0.002	0.	0.	0.018
1801–1900	20	3	0	0	500.0	586.3	596.3	596.3	596.3	0.040	0.005	0.	0.	0.039
1901–2000	8	4	1	0	478.7	570.0	580.9	581.1	581.1	0.017	0.007	0.002	0.	0.022
2001–2100	15	1	0	0	457.6	551.2	562.6	562.6	562.6	0.033	0.002	0.	0.	0.028
2101–2200	12	3	1	0	433.1	530.7	544.1	544.1	544.1	0.028	0.006	0.002	0.	0.029
2201–2300	9	1	0	0	405.8	500.4	512.5	513.5	513.5	0.022	0.002	0.	0.	0.019
2301–2400	14	5	1	0	359.2	448.7	459.8	460.9	460.9	0.039	0.011	0.002	0.	0.043
2401–2500	12	1	0	0	309.3	395.5	407.0	409.0	409.0	0.039	0.003	0.	0.	0.032
2501–2600	11	0	1	0	255.9	339.1	350.6	353.1	353.1	0.043	0.	0.003	0.	0.034
2601–2700	5	4	0	0	211.0	298.5	309.8	312.4	312.4	0.023	0.013	0.	0.	0.029
2701–2800	6	4	1	0	189.2	258.0	271.4	273.7	273.7	0.032	0.016	0.004	0.	0.040
2801–2900	6	1	0	1	163.9	224.3	239.3	240.4	240.4	0.037	0.004	0.	0.004	0.033
2901–3000	3	2	0	0	147.4	202.8	215.8	215.8	215.8	0.020	0.010	0.	0.	0.023
3001–3100	4	0	0	0	130.4	179.8	189.1	189.1	189.1	0.031	0.	0.	0.	0.021
3101–3200	2	2	0	0	114.6	155.3	162.4	162.4	162.4	0.017	0.013	0.	0.	0.025
3201–3300	1	2	0	0	95.6	128.2	134.5	134.5	134.5	0.010	0.016	0.	0.	0.022
3301–3400	3	1	0	0	77.9	104.2	109.3	109.3	109.3	0.039	0.010	0.	0.	0.037
3401–3500	4	0	0	0	70.7	92.6	97.6	97.6	97.6	0.057	0.	0.	0.	0.041
3501–3600	1	0	0	0	60.2	82.2	86.5	86.5	86.5	0.017	0.	0.	0.	0.012
3601–3700	1	1	0	0	52.1	70.8	75.2	75.2	75.2	0.019	0.014	0.	0.	0.027
3701–3800	2	0	0	0	43.0	57.5	61.5	61.5	61.5	0.047	0.	0.	0.	0.033
3801–3900	1	0	0	0	36.8	48.6	51.6	51.3	51.3	0.027	0.	0.	0.	0.019
3901–4000	0	0	1	0	32.3	42.1	44.1	44.1	44.1	0.	0.	0.023	0.	0.023
4001–4100	1	1	0	0	26.2	34.9	37.0	37.0	37.0	0.038	0.029	0.	0.	0.054
4101–4200	0	0	0	0	20.6	26.7	29.0	29.0	29.0	0.000	0.	0.	0.	0.000
4201–4300	1	0	0	0	16.1	19.4	20.4	20.4	20.4	0.062	0.	0.	0.	0.049
4301–4400	0	0	0	0	10.6	14.4	15.4	15.4	15.4	0.	0.	0.	0.	0.000
Sum	235	44	6	1										

Table 12 shows USAREUR M60-tank-engine replacement rates calculated by the procedure described above. The total sample is composed of 639 tanks. The decline in numbers of tanks shown in cols 6 to 10 of Table 12 reflects both factors that reduce the denominators (i.e., occurrence of engine replacement and insufficient tank mileage). Because this routine accumulates vehicle usage in tenths of usage intervals completed, the vehicle-sample densities shown are not whole numbers. The computer routine developed to perform calculations such as these is described in App A. Tables for selected M60 tank and M113 APC parts are contained in App B.

Chapter 3

PROJECTION OF REPLACEMENT RATES

ALTERNATIVE METHODS

Once replacement rates have been determined for each usage interval (each 100 miles of operation in Table 12), the next step is to establish a means of projecting these rates into the future.

One method of projecting rates and estimating parts replacements frequently used by RAC analysts is based on a collection of mathematical techniques referred to as "renewal theory."[9] The use of this methodology depends on being able to calculate replacement rates of the $R_{s/c}$ type described in Chap. 2. The calculation of $R_{s/c}$ rates in turn depends on being able to identify first-, second-, third-, and higher-order replacements. If information is available only for first-order replacements, certain assumptions are made about the rate at which second-, third-, fourth-, and higher-order replacements will occur. For example, assumptions could be made that replacement parts will furnish 50, 75, or 100 percent of like-new performance; the parts needs resulting from the application of these different assumptions can then be compared. A RAC technical paper[10] describes in detail the methodology of this forecasting technique and utilizes it in the prediction of engine requirements for the USAREUR M60 tank fleet during the period 1964 to 1967.

It is usually difficult to identify the order of replacement of a given part, however. In the first place this identification requires data extending back to the original issue of the end item on which the part is found; such information is frequently not available for end items that have been in the supply system for a protracted period. In the second place, considerable hand editing is frequently required in the analysis of data of this type. Since the objective of this study is to develop automated forecasting techniques that can readily be applied to the large volumes of data in the TAERS data bank, simplified mathematical techniques based on $R_{a/o}$ rather than $R_{s/c}$ replacement rates were developed.

In developing a means of projecting either of these replacement rates into the future, the two basic steps involved are (a) combining the observed replacement rates for each usage interval into a mathematical equation and (b) using this equation to forecast replacement-rate patterns. This chapter describes these two steps as applied to USAREUR M60 tank engine data.

TRANSFORMATION OF DATA INTO MATHEMATICAL EQUATIONS

In Chap. 2, USAREUR M60 tank-engine replacement data and rates for various mileage intervals were shown in Table 12. Figure 3 shows these same replacement rates in graphic form.

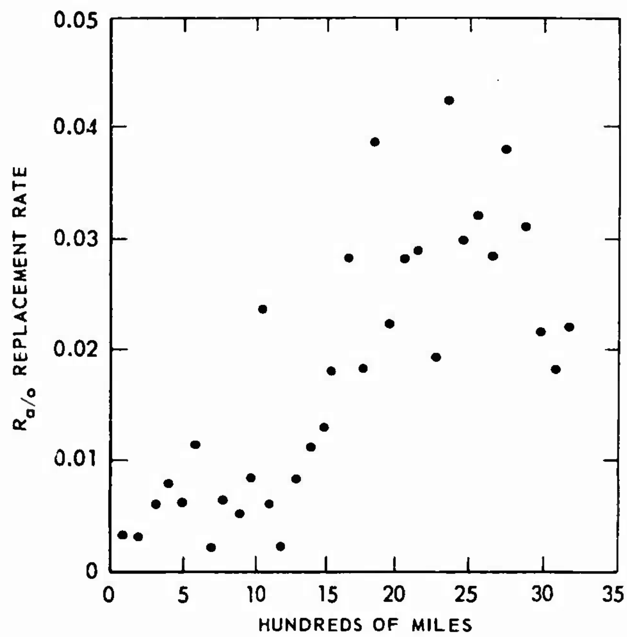


Fig. 3—$R_{a/o}$ Replacement Rates of USAREUR M60 Tank Engines

There are several methods of transforming such individual data points into a single mathematical equation. One of the most commonly utilized is the least squares technique. Its application produces the single "curve" (not necessarily curved in shape) of a particular type that best fits the individual data points; the curve of best fit is considered to be the one for which the sum of the squares of the distances between the data points and the curve is a minimum.

For data points fitted to a straight line, Fig. 4 illustrates the least squares technique. A, B, C, D, and E represent data points. The straight line pq results from the application of the least squares technique. The letters a, b, c, d, and e represent the distance between the data points and the straight line. The position of the line is such that if one squares each distance (i.e., $a \times a$, $b \times b$, $c \times c$, $d \times d$, and $e \times e$) and adds the squared distance figures together, the sum is smaller than for any other straight line that can be drawn through the data points.

In addition to the straight line, other types of curves can be fitted to the data. Four of the most common types of curves are illustrated in Fig. 5. The linear, log-log, and semilog curves have been developed through the application of least squares techniques.

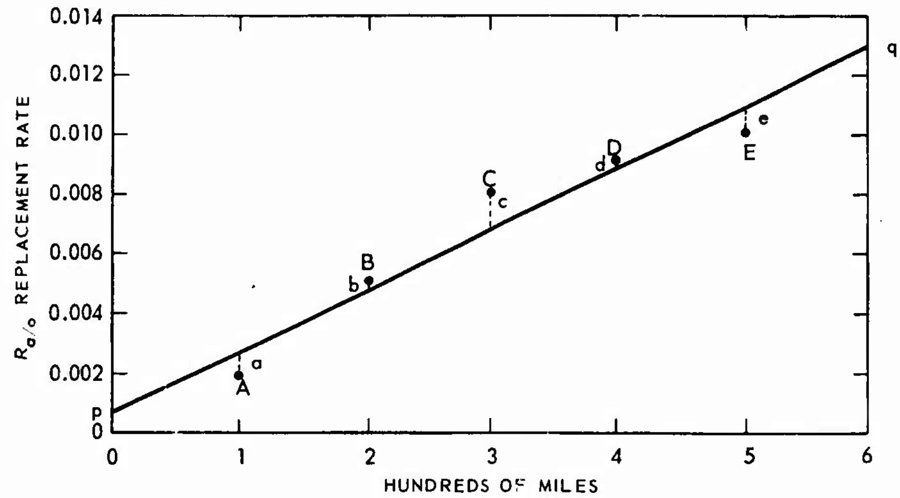


Fig. 4—Illustration of Linear Curve Fitted to Data Points by Least Squares Technique

Constant Replacement-Rate Curve. The simplest of all possible types of curves expresses replacement rates as a constant or average rate over the mileages observed. From Fig. 5a it is evident that this type of curve is a rather poor representation of engine-replacement activity. All observations from 0 to 1600 miles fall below the average rate of replacement, whereas all observations between 1600 and 3200 miles equal or exceed the average. (The degree of scatter is greater above 1600 miles than below because of the reduction in the number of tanks observed at the higher mileages.

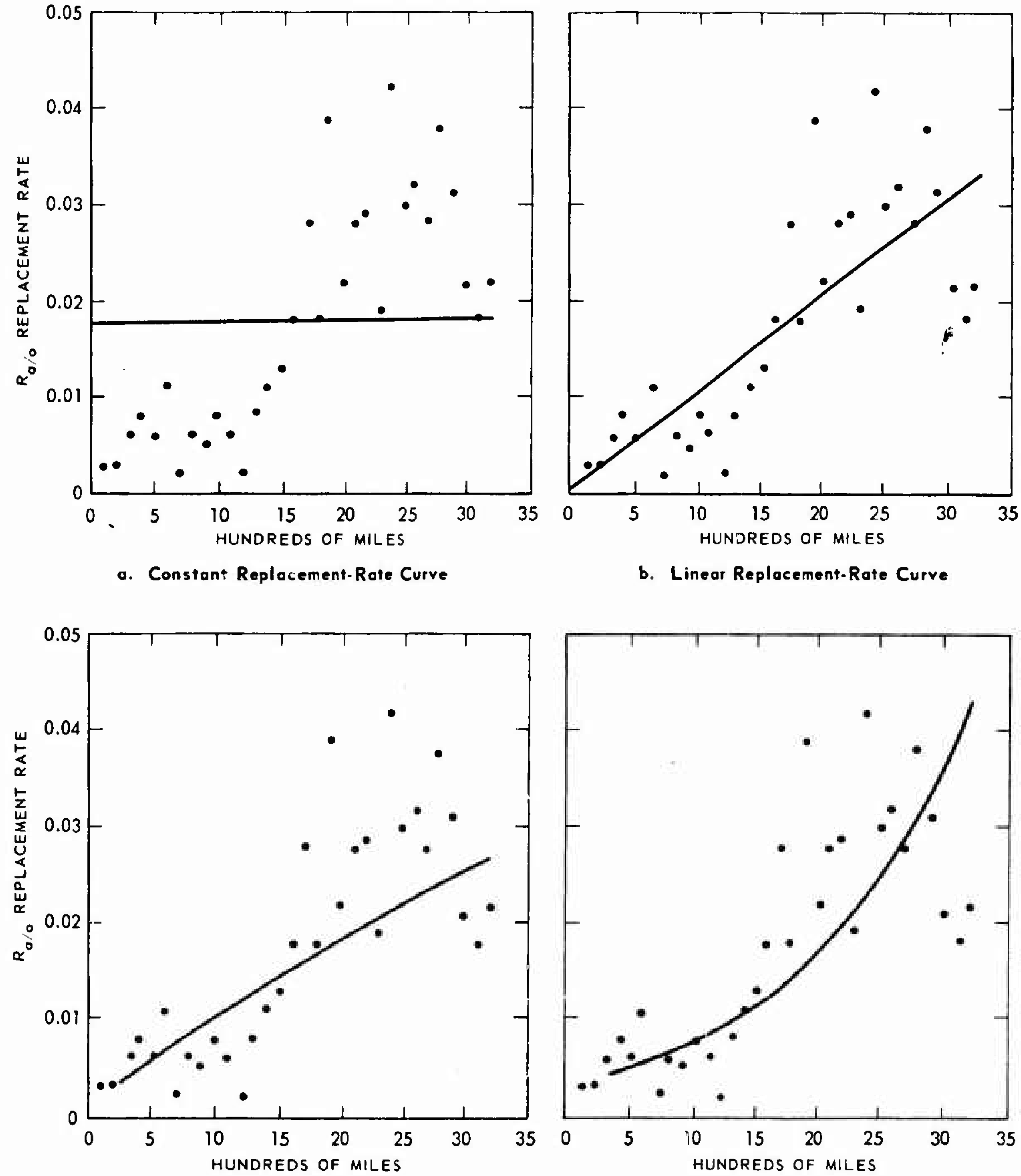
Linear Replacement-Rate Curve. In Fig. 5b the $R_{a/o}$ replacement-rate curve is expressed as the straight line that best fits the data according to least squares criteria. The slope of the line indicates that the rate of engine replacement tended to increase over the range of mileages observed.

Log-Log Replacement-Rate Curve. Another common type of mathematical relation to which the individual replacement rates can be fitted is the log-log curve, also called the double-log curve. At first sight the log-log curve for the USAREUR M60-tank-engine data looks quite similar to the linear curve. However, a closer examination of Fig. 5c reveals that the $R_{a/o}$ replacement rate is increasing at a constant rate for the linear relation but is increasing at a decreasing rate for the log-log curve.

Semi-Logarithmic Replacement-Rate Curve. A fourth kind of mathematical expression that can be used to summarize the replacement-rate experience observed is a semi-logarithmic (semi-log) type curve. A semi-log curve fitted to the USAREUR M60 tank data indicates that the $R_{a/o}$ replacement rate for tank engines is increasing at an increasing rate (see Fig. 5d).

PROJECTION OF REPLACEMENT-RATE PATTERNS

The elementary types of replacement-rate curves discussed above are summarized in Table 13.



a. Constant Replacement-Rate Curve

b. Linear Replacement-Rate Curve

c. Log-Log Replacement-Rate Curve

d. Semilogarithmic Replacement-Rate Curve

Fig. 5—Replacement-Rate Curves Fitted to USAREUR M60-Tank-Engine Replacement Data

TABLE 13

Elementary Types of Replacement-Rate Curves Considered for USAREUR M60-Tank-Engine Data

Type of rate curve considered		Replacement trend
Common name	Math notation	
Average	$R_{a/o} = A$	Constant
Linear	$R_{a/o} = A + Bx$	Increasing at constant rate
Log-log	$R_{a/o} = Ax^B$	Increasing at decreasing rate
Semilog	$R_{a/o} = AB^x$	Increasing at increasing rate

Other types of replacement equations could also have been considered, of course, but the elementary ones shown are descriptive of a wide variety of replacement activity. Where more sophisticated types of equations are considered more applicable than those listed in Table 13 and when the quality of the data is known to warrant their use, the computer program described in Chap. 4 and App D of this study can be adapted to reflect more complex replacement patterns.

In projecting observed replacement-rate experience into future time periods, it must be decided which of the types of curves shown in Fig. 5 and Table 13 are most suitable. One method of selection might be to choose the type of curve that most closely fits the data during the period observed. On this basis the semi-log curve (Fig. 5d) would be selected. But a projection of the semi-log rate for another 3200 miles would indicate that by 6400 miles 37 of 100 tank engines would require replacement per 100 miles of operation, a rate of replacement that appears much too high. For this reason and because the constant replacement rate may greatly understate replacement activity, the log-log and linear equations have been given primary attention in the analysis that follows. Two other factors also lend support to the selection of log-log and linear curves: (a) vehicle components that experience aging frequently appear to follow log-log type behavior, and (b) linear projections provide a widely accepted kind of replacement estimate to compare with log-log projections.

Once the appropriate mathematical equation(s) has been selected, projection to future mileages is a relatively simple matter of extending the replacement curves on the basis of the pertinent equation. Appendix C provides replacement-rate information for linear and log-log equations for selected M60 tank and M113 APC repair parts. The repair-parts replacement rates for individual usage intervals presented in App B were used as inputs into a least squares statistical analysis routine to develop the information furnished in App C.

Chapter 4

ESTIMATION OF EXPECTED NUMBER OF PARTS REPLACED

INTRODUCTION

Chapter 2 discussed techniques utilized in determining parts-replacement rates; Chap. 3 explained the method used in this study to project replacement rates into the future. The final step is that of developing techniques for applying these projections to a given vehicle fleet for a specified time period in the future. The result of this application will be an estimate of the quantity of a given repair part that will be needed during this future time period; the estimate will reflect both the mileage distribution of the fleet and the mileage-dependent replacement rate for the part, projected from past maintenance experience. A detailed description of the computer routine Expected Number of Replacement Actions, developed to produce this estimate, is found in App D. This chapter provides a nontechnical description of the mathematical principles incorporated into the routine.

Table 14 represents a hypothetical example that illustrates the principle of how replacement rates and end-item usage distributions are combined. This table assumes a fleet of 60 vehicles that use part X; the vehicles travel an average of 100 miles/month.

TABLE 14

Expected Replacements of Part X Required for Fleet of 60 Vehicles during Current 1-Month Period

(Rate of utilization 100 miles/month)

Usage interval, miles (1)	Vehicles using part X (2)	$R_{a/o}$ replacement rate (3)	Intervals for which estimate was made (4)	Estimated replacements (5) = (2) × (3) × (4) (5)
0–100	5	0.02	1	0.10
101–200	10	0.03	1	0.30
201–300	15	0.04	1	0.60
301–400	15	0.05	1	0.75
401–500	10	0.06	1	0.60
501–600	5	0.07	1	0.35
Total	60			$2.7 \cong 3$

Column 1 shows the various usage intervals expressed in miles. Column 2 shows the number of vehicles in each mileage interval; it is assumed that this distribution is based on current information. Column 3 gives the $R_{a/o}$ replacement rate for each mileage interval, rates derived by the techniques described in Chap. 2. Column 4 indicates that in this table the parts needs are being calculated for only one interval, i.e., for 100 miles or 1 month. Column 5 represents the number of replacements of part X expected for the entire fleet during this 1-month period. It is computed by multiplying cols 2 x 3 x 4 for each usage interval and then adding the products together to obtain a total figure for the entire fleet. In this case a total of three replacements of part X would be expected during the current 1-month period.

It must be recognized, however, that information about fleet mileage distribution is usually not available at the NICP level on a current basis; the out-of-date mileage distribution must therefore be updated, usually on the basis of average rates of utilization observed for the fleet over a recent period of time. Table 15 illustrates how the computer technique handles this updating problem

TABLE 15

Updating of Mileage Distribution of Vehicles Using Part X Based on End-Item Usage Information Obtained 3 Months Ago

(Rate of utilization 100 miles/month)

Usage interval, miles	Vehicles using part X 3 months ago	Vehicles using part X today
0–100	5	
101–200	10	
201–300	15	
301–400	15	5
401–500	10	10
501–600	5	15
601–700		15
701–800		10
801–900		5
Total	60	60

for a hypothetical 60-vehicle fleet. In this case it is assumed that the latest available information on fleet mileage distribution is 3 months old. The average rate of utilization for the fleet during the last year has been 100 miles/month, and in the absence of contravening usage directives it is assumed that this rate has continued during the last 3 months. The updating therefore becomes a relatively simple matter of shifting the entire distribution 300 miles forward, as shown by the arrows leading from the second to the third column in Table 15. Such an updating technique assumes that there is effective command control of utilization and that there is no increment or loss in the vehicle sample.

The numbers in the last column of Table 15 represent the mileage distribution of the hypothetical vehicle fleet projected to the present. In most cases,

however, the decision to procure a given part is made a considerable time before it is expected that the parts ordered will actually enter the supply system. It is therefore important to know what the mileage distribution of the fleet will be at that future date, for the condition of the fleet at that time will affect the need for parts.

Another step of mileage-distribution data updating is therefore incorporated into the computer routine developed by this study; this routine is illustrated for the hypothetical 60-vehicle fleet in Table 16.

Column 2 shows the present mileage distribution of the fleet. The estimate of need for part X is to be developed for an average of 900 miles of vehicle use beginning 8 months from the present. The future rate of utilization cannot be determined precisely; the average rate in the past, seasonal variations, and changes in official policy must be considered. For purposes of illustration it is assumed that in this case average utilization during the next 8 months will be 75 miles/month. (This change from the previous average of 100 miles/month demonstrates the capability of the computer routine to handle different utilization rates in each of the two updating steps.)

The arrows leading from col 2 to col 3 in Table 16 show the change in fleet mileage distribution that occurs during an 8-month period if utilization averages 75 miles/month: the entire distribution moves 600 miles forward. Linear projections of Table 14 replacement rates are shown in cols 4 and 5.

TABLE 16

Expected Replacements of Part X Required for Fleet of 60 Vehicles for 900 Miles of Use, Beginning 8 Months from Present Date

(Rate of utilization: 75 miles/month)

Usage interval, miles (1)	Vehicles using part X today (2)	Vehicles using part X 8 months in future (3)	$R_{a/o}$ replacement rate: Beginning of forecast period (4)	$R_{a/o}$ replacement rate: End of forecast period (5)	$R_{a/o}$ replacement rate: Average for forecast period (6)	Intervals[a] for which estimate made (7)	Estimated replacements for 900 miles (12 months), beginning 8 months in future 7 – 2 × 5 × 6 (8)
0–100							
101–200							
201–300							
301–400	5						
401–500	10						
501–600	15						
601–700	15						
701–800	10						
801–900	5						
901–1000		5	0.11	0.20	0.155	9	6.975
1001–1100		10	0.12	0.21	0.165	9	14.850
1101–1200		15	0.13	0.22	0.175	9	23.625
1201–1300		15	0.14	0.23	0.185	9	24.975
1301–1400		10	0.15	0.24	0.195	9	17.550
1401–1500		5	0.16	0.25	0.205	9	9.225
Total							97.200 or 98

[a]Each interval represents 100 miles. Nine intervals = 900 miles or 12 months at 75 miles per month.

Columns 4, 5, and 6 show the $R_{a\,o}$ rates at the beginning of the forecast period, the rates at the end of the period, and the average rates for the entire forecast period, respectively. These rates are used in calculating estimated replacements because they reflect the fleet aging that occurs during the forecast period itself. Column 7 indicates that parts needs are to be forecast for nine intervals of 100 miles each; this situation represents 900 miles of use or 12 months of time if utilization is 75 miles/month. Column 8 shows the estimated number of parts required for this fleet during 12 months or 900 miles of use. The figures in col 7 are obtained by multiplying cols 3 x 6 x 7, giving a total of 98 replacements for the entire fleet.

COMPUTER INPUT AND OUTPUT

In the previous section of this chapter a hypothetical example was used to demonstrate the steps by which the Expected Number of Replacement Actions Routine produces an estimate of needs for part X during a future period of time.

This section will give examples of actual computer input and output, i.e., the information format submitted to and the report format obtained from the computer routine developed by this study.

Information Format

Figure 6 is an example of the information format that serves as a computer input. Each line is described below.

1. Name and Federal Stock Number (FSN) of end item on which the part is used.
2. Name and FSN of repair part for which the forecast is being made.
3. Organization for which the parts forecast is being made. The computer routine automatically selects and utilizes pertinent stored data on replacement rates and end-item usage distributions.

1. End item: M60 tank FSN 2350-678-5773
2. Repair part: Engine FSN 2815-679-4963 and 2815-856-4996[a]
3. Organization: USAREUR
4. Forecast period: Begins 4275
5. Forecast period: Extends 200 miles
6. Usage measure: Miles
7. Usage interval: 100 miles
8. Date of study: 4214
9. Date of end-item inventory: 4183
10. Estimated rate of end-item utilization from inventory to date of study: 67 miles month
11. Estimated rate at end-item utilization from date of study to beginning of forecast period: 67 miles month

Fig. 6--Example of Computer Input Information Format in Estimating Parts Replacement

Forecast of repair-parts consumption: estimated number of parts replaced.

[a]In this case engines with two different FSNs were used in the M60 tank. For the purpose of replacement analysis the two were combined.

4. Beginning of the period for which parts needs will be forecast, expressed as a Julian date.* In this example the forecast period begins 1 October 1964 (Julian date: 4275).
5. Duration of forecast period. In this example parts needs are forecast on the basis of miles; the duration could, however, be expressed in months, rounds fired, operating hours, landings made, or any other suitable measure of usage.
6. Unit of measure used to describe duration of period for which the forecast is being made. In this example it is miles, but it could be any of the usage measures listed in 5.
7. The size of the usage interval for which end-item distribution is obtained and for which separate parts-replacement rates will be calculated. In this case 100-mile intervals corresponding to those of Tables 14, 15, and 16 were used.
8. Julian date on which study is undertaken, in this example 1 August 1964 (4214).
9. Julian date on which latest end-item inventory was made—in this case the date of latest information on the mileage distribution of the M60 tank fleet, 1 July 1964 (4183). This date is usually earlier than the date of the study shown in 8, since completely current information of this type is not customarily available.
10. Rate of utilization used to update fleet mileage distribution from time of latest inventory (1 July 1964) to the date of the study (1 August 1964). This is the type of figure used in performing the updating demonstrated in Table 15 earlier in this chapter.
11. Rate of utilization used to project the fleet mileage distribution from the date of the study (1 August 1964) to the beginning of the forecast period (1 October 1964). This is the type of figure used in performing the second updating that was demonstrated in Table 16 earlier in this chapter.

Report Format

Figure 7 is an example of the Expected Parts Replacement Report produced by the computer when using the routine developed by this study. Since this report is printed by the computer immediately after the information shown in Fig. 6, there is no need to repeat identification of end item, part, organization, etc.

Line 1 shows that this estimate is based on $R_{a,o}$ replacement rates for tank engines rather than the $R_{s,c}$ rate; both of these rates and the reason for using the $R_{a,o}$ rate were discussed in Chap. 2.

Line 2 indicates that the projection of replacement rates was performed on the basis of a log-log curve, as discussed in Chap. 3.

Lines 3 and 4 represent the numerical values for A and B, the constants in the log-log replacement-rate equation (see Table 13). The values for A and B were computed by employing least squares techniques in the manner described in Chap. 3.

*A Julian date consists of two parts: the first digit identifies the specific year within a decade; the remaining three digits represent the particular day of the year, 1 January being day number 001, 31 December being day number 365.

(1) Type of rate: $R_{a/o}$
(2) Type of usage relation: Log-log
(3) Equation constant: A = 0.0016
(4) Equation constant: B = 0.8054

(5) Usage interval	(6) Quantity of end items in usage interval	(7) Estimated number of parts replaced
201–300	115	1.1
301–400	78	0.9
401–500	45	0.6
501–600	42	0.7
601–700	36	0.6
701–800	22	0.4
801–900	44	0.9
901–1000	27	0.6
1001–1100	41	1.0
6101–6200	2	0.2
6201–6300	5	0.5
6301–6400	2	0.2
6401–6500	3	0.3
	Sum	90.3 = 91

Fig. 7—Example of Expected-Parts-Replacement Report Produced by IBM 7040 Computer Routine

Column 5 lists the various usage intervals, in this case hundreds of miles.
Column 6 represents the estimated number of end items (in this case M60 tanks) of various mileages that will be in the inventory during the forecast period, based on a projection of latest available mileage distribution data.
Column 7 gives the desired end result of the entire computer routine developed by this study: an estimate of the number of parts that will be replaced during the forecast period. In this particular example the estimate represents a 1 August 1964 estimate of the number of M60 tank engines that will be replaced in USAREUR during a 200-mile (3-month) interval beginning 1 October 1964, assuming a constant average utilization rate of 67 miles/month and basing the estimate on the mileage distribution of USAREUR M60 tanks as of 1 July 1964.

In using the Expected Number of Replacements Routine, a commodity analyst needs to specify only the information shown in Fig. 6. The routine automatically references the required replacement rate and end-item usage data compiled from organization- and field-level maintenance records and processed by auxiliary computer routines. For any end item, repair part, using organization, and forecast period specified for which data are available, the Expected Number of Replacement Actions Routine provides an estimate of the number of parts that will be replaced.

Forecasts of repair-parts consumption for selected M60 tank repair parts during the period from the third quarter of 1964 to the fourth quarter of 1965 are presented in App E.

Chapter 5

APPLICATION OF METHODOLOGY

RECAPITULATION

Previous chapters of this technical memorandum have described the methodology developed for preparing estimates of the number of replacements of a given repair part that will occur during a given usage interval. The three steps of the methodology presented in Chaps. 2, 3, and 4, respectively, consisted of (a) determining the replacement rate of the given repair part for individual usage periods, (b) developing a means of projecting these age-dependent rates into future time periods, and (c) combining projections of replacement rates and end-item usage inventories to obtain estimates of the number of repair parts expected to be replaced.

Chapter 2 described two major types of replacement-rate calculations: the $R_{a/o}$ rate, which measures all replacements regardless of order; and the $R_{s/c}$ rate, which deals with only a single order of replacement (i.e., first, second, or third, etc.). Because of the difficulty in identifying order of failure, the $R_{a/o}$ rate has been emphasized in this study. Chapter 3 described the combining of individual replacement rates into a simple mathematical equation through least squares techniques and discussed the reasons for projecting replacements into the future on the basis of linear and log-log curves. Chapter 4 then described the prediction of parts replacements. The first step involved updating the vehicle usage distribution to the date of the study and then projecting this distribution to the beginning of the forecast period. The second step consisted of applying the projected replacement rates to the projected fleet usage distribution to obtain the number of replacements expected to occur during the forecast period.

This chapter discusses applications of the methodology developed by the study. The first half of the chapter described several difficulties that may arise in utilizing the methodology; the latter half illustrates a number of its potential benefits.

DIFFICULTIES

The fact that a given repair part may be used on more than one vehicle (i.e., may have multiple applications) or that two or more repair parts may be

used interchangeably (i.e., are substitutes) somewhat complicates the application of the methodology. The accompanying tabulation illustrates the possible combinations of multiple applications and substitution of repair parts.

Number of end items on which part is applied	Number of interchangeable repair parts	
	1	2 or more
1	A	C
2 or more	B	D

Combination A above (one repair part used on one end item) is the situation that has been assumed in previous sections of this paper. Combination B is the condition where one repair part is used on two or more end items. Combination C describes the situation in which one end item uses either of two or more repair parts that are substitutable and have different FSNs. Combination D represents a condition in which two or more substitutable repair parts are used on two or more end items.

The applicability of the computer routine to combinations B, C, and D is discussed in separate sections of this chapter.

One Repair Part Used on Two or More End Items (Situation B)

For purposes of illustration it will be assumed that part X is used on both vehicle A and vehicle B. In order to determine the total expected number of replacements of part X the expected number of replacements of part X on vehicle A and the expected number of replacements of part X on vehicle B must be available. The first is determined from the $R_{a/o}$ replacement rates and the usage distribution of end items, or more specifically from (a) the number of replacements of part X on vehicle A, (b) the quantity of vehicle A observed, and (c) the usage distribution of vehicle A; the expected number of replacements of part X on vehicle B is determined from (d) the number of replacements of part X on vehicle B, (e) the quantity of vehicle B observed, and (f) the usage distribution of vehicle B.

All the information necessary to calculate a to f is available from TAERS data. Some inconvenience may result from the fact that the commodity analyst will be required to add together the two replacement estimates, but the data and methodology are adequate to provide the total expected number of replacements of part X.

Two Repair Parts Used on One End Item (Situation C)

In this case it is assumed that either part X or part Y, which are substitutable but not identical, are used on vehicle A. Two separate estimates of replacements would be desirable: the expected number of replacements of part X on vehicle A and the expected number of replacements of part Y on vehicle A. The first is determined from (a) the quantity of part X removed from vehicle A, (b) the quantity of vehicle A using part X, and (c) the usage distribution of vehicle A using part X; the expected number of replacements of part Y on vehicle A is determined from (d) the quantity of part Y removed from vehicle A, (e) the quantity of vehicle A using part Y, and (f) the usage distribution of vehicle A using part Y.

None of these pieces of information is available from TAERS data. When either part X or part Y is replaced, the maintenance action record does not show the FSN of the part that is removed; it is therefore not known whether the part replaced was type X or Y. Furthermore, when vehicles are issued it is not usually known which were equipped with part X and which were equipped with part Y. Therefore none of the information required in a to f is available from TAERS.

If part Y represented a modification of part X based on user comments and/or extensive research, it would be desirable to be able to compare the replacement rates of the two parts. For the reasons described above it is not possible to make this comparison with the data now available.

This does not mean, however, that no replacement analysis can be performed. In the example given above, an estimate of total replacements for vehicle A can be made. Although this estimate does not distinguish between part X and part Y, it nevertheless furnishes a helpful combined forecast of the combined replacement of both parts for the total vehicle fleet.

Two Repair Parts Used on Two End Items (Situation D)

In this case it is assumed that part X and part Y are used interchangeably on vehicles A and B. For the reasons described in Situation C above, it is not possible to determine separate replacement rates for part X and part Y on vehicle A. It is, however, possible to calculate a combined rate of replacement for part X plus part Y on vehicle A and to perform the same type of calculation for vehicle B.

BENEFITS

Several benefits may be derived from TAERS data analyzed according to the techniques developed in this study. Such information can be useful at various times during the utilization period of a given end item and its pertinent repair parts.

Newly Introduced End Item; No Stable Demand Pattern Established for Parts

Although the introduction of a new end item into the supply system is followed by a period during which no demand pattern for parts has yet been established, procurement actions should be instigated to meet future needs. During this period, information from certain using units can be an effective basis for predicting future parts needs for the end-item inventory as a whole. These are units whose vehicles accumulate more utilization (miles, rounds, etc.) than those in other units. This may be simply because their end items are used more extensively or because the end item was issued to them earlier than to other units. In either case the replacement experience of these "older" end items can serve as a helpful indicator of future parts needs.

An example of the value of consumption data during the early life of a new end item is demonstrated by the experience with M60 tank track in USAREUR in late 1962 and early 1963. During this period September–November 1962

RAC research teams were gathering parts-replacement data for M60 tanks in USAREUR.[1] The first M60 tanks in USAREUR had been issued to the 1st Bn, 33d Armor, 3d Armd Div in May 1961. Data gathered by RAC analysts showed that by the fall of 1962 the large majority of the tanks in this unit had experienced replacement of complete sets of track between 1800 and 2800 miles (see Fig. 8). On the basis of these consumption data (which are similar to those

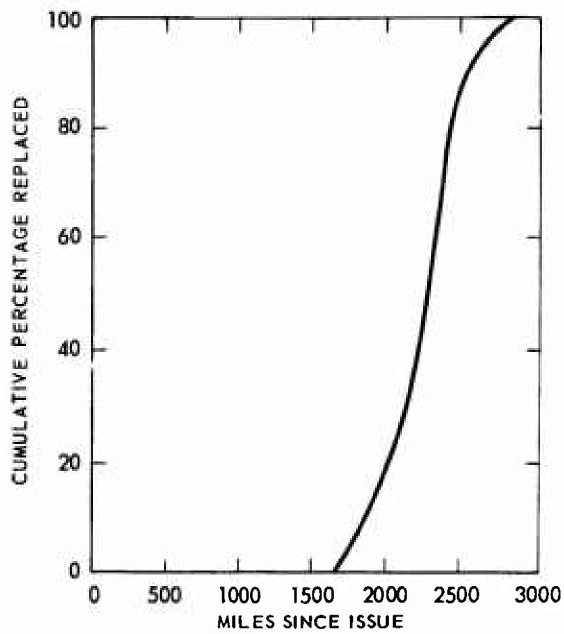


Fig. 8—Cumulative Percentage of M60 Tank Track-Shoe Assemblies Replaced in 1st Bn, 33d Armor, 3d Armd Div

available in TAERS) it was possible to forewarn Army authorities of the impending large-scale demands for track that would result when the remainder of the USAREUR tank fleet entered this critical usage interval. Prompt action was taken to alleviate the imminent shortage.

End Item Continuing in Inventory: Demand Pattern Established

When an end item has been in inventory for a sufficiently long time, demand data are generated, summarized in average quarterly demand reports, and used as the basis of forecasting future parts needs. As was indicated in Chap. 1, demand information has not furnished a completely satisfactory basis for forecasting. The consumption information obtained from TAERS data and analyzed by the methods described in this study could be used to prepare average quarterly consumption reports; these could be used at present to supplement—and perhaps later to supplant—the average quarterly demand reports as a basis for parts-needs forecasting.

End Item Leaving Supply System: Demand for Parts Declining

Because of rapid improvements in technology, new end items are frequently phased into the inventory while the older models are phased out. This changeover frequently involves a period of time during which parts for both old and new end items must be available.

During this period a considerable supply of old-model parts may be in the supply system. Frequently this situation is coupled with a low demand for the parts because of the decreasing old-model end-item population. If parts-needs forecasts are based only on demand data, some of the supplies of parts may be declared in excess and removed from the system. However, if the old end item remains in the system for a considerable period of time, this disposal of excess may later prove to be both premature and embarrassing; there may be a need to procure the same parts that were earlier disposed of. Therefore if usage-dependent replacement rates based on consumption data are developed for these end items, parts needs can be more accurately predicted and appropriate parts supplies maintained within the system.

Appendix A

DESCRIPTION OF EVENTS RATES COMPUTER ROUTINE

INTRODUCTION

This appendix presents a description of the computer routine used to develop the repair-parts replacement rates described in Chap. 2 and shown in summary form in App B. A general description of the routine is given in the next section of this appendix, followed by a detailed discussion in the last section.

Throughout this appendix the terms "events" and "events rates" will be used because the routine has been constructed to be sufficiently general to analyze any kind of event. It converts raw data of the form "event X occurred to equipment Y at equipment age Z" into an event rate. In studying vehicle maintenance, for example, the routine could be used to develop rates based on replacement, repair, or adjustment actions or on any combination of these actions.

GENERAL DESCRIPTION

An outline of the flow and generation of information in the Events Rates Routine is shown in Fig. A1. The routine requires two types of data files: an events file and an equipment sample file. For the events file the following information is needed: event identification code (repair, adjustment, or replacement), equipment serial number, and equipment usage (e.g., age, miles, rounds, landings) at the time the event occurred. For each item in the sample the following data must be in the equipment sample file: serial number, usage at which observation in the sample began, and the usage at which observation ended.

Use of the rates routine requires the existence of an appropriate sort routine for each of the two data files. Beginning with the two sorted files the rates routine proceeds in two phases.

Phase I places the desired elements of the two basic data files on one tape. During this phase it is possible to select any subsample and any type of event for analysis. The format of Phase I output is a sequence of one or more "jobs." Each job is composed of at least two data blocks. The first data block in each job is the equipment sample or subsample. Each remaining data block in the job is a specific event for which a rate is to be computed. This output is used as input to Phase II.

Phase II computes events rates for each job on the Phase I output tape. In the first of the two steps in this computation a usage interval (for example, 100 miles) is specified and a frequency count of events and equipment is made for each interval of a contiguous set of such usage intervals, beginning at usage 0 and ending with the interval containing the usage of the oldest sample or subsample. These two frequency counts are printed as the events table and the equipment-sample density table. In the second step the events rate for each usage interval is computed. The rate is computed in the $R_{s/e}$, $R_{a/o}$, and

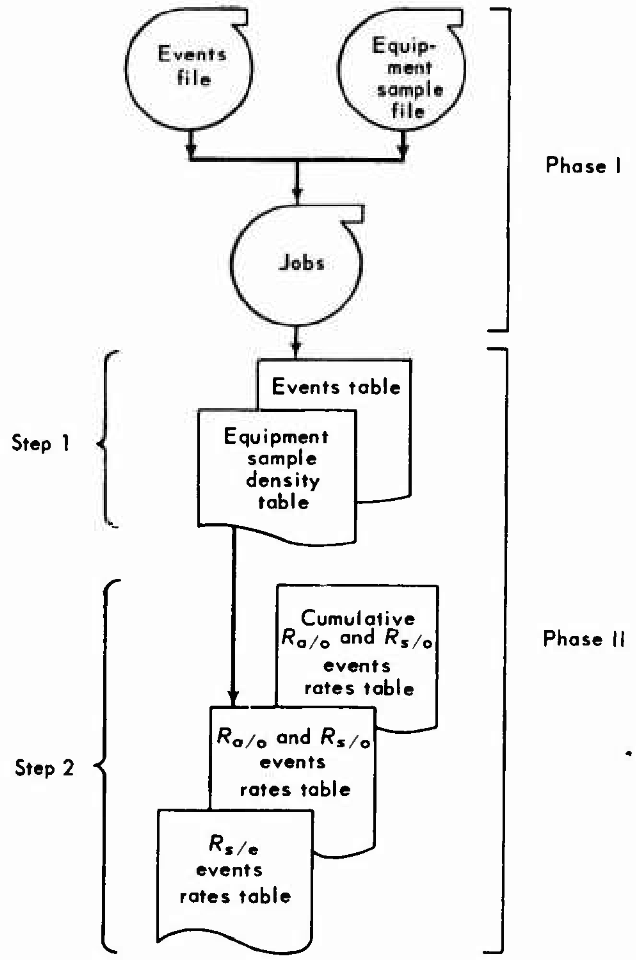


Fig. A1—Flow and Generation of Information in Events Rates Routine

cumulative $R_{a/o}$ forms. Rates are also computed in a mixed form $R_{s/o}$, which was not described in Chap. 2. The subscript s/o of this replacement rate indicates that for each usage interval, the number of replacements of a specific order s, is divided by, the number of vehicles observed and available to fail o. The cumulative $R_{s/o}$ is also computed and shown in tabular form.

The printed output of the rates routine is contained on six pages. Examples of these six pages for M60 tank-engine replacements are shown in Figs. A2 to A7. The formats of the tables shown in Figs. A3 to A7 are similar. These tables are basically 9 by 50 arrays in which the nine columns from left to right correspond to event orders 1 to 9 and the 50 rows from top to bottom correspond to age intervals (numbered 1 to 50) of the size stated on the cover page (Fig. A2). Sometimes 10th-col and/or 51st-row entries appear; these are row and column sums, respectively.

M60-TANK-ENGINE REPLACEMENT-RATE OUTPUT

Maintenance Events Rates vs Age

Vehicle	M60 Tank
Sample	Total
Age Segment	100 Miles
Event	Engine

Fig. A2- Example of Cover Page, M60 Tank-Engine Replacement-Rate Output

Usage Interval, Miles	Quantity Replaced 1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order	8th Order	9th Order
0-100	2.	0.	0.	0.	0.	0.	0.	0.	0.
101-200	2.	0.	0.	0.	0.	0.	0.	0.	0.
201-300	4.	0.	0.	0.	0.	0.	0.	0.	0.
301-400	4.	1.	0.	0.	0.	0.	0.	0.	0.
401-500	3.	1.	0.	0.	0.	0.	0.	0.	0.
501-600	7.	0.	0.	0.	0.	0.	0.	0.	0.
601-700	1.	0.	0.	0.	0.	0.	0.	0.	0.
701-800	4.	0.	0.	0.	0.	0.	0.	0.	0.
801-900	3.	0.	0.	0.	0.	0.	0.	0.	0.
900-1000	5.	0.	0.	0.	0.	0.	0.	0.	0.
1001-1100	4.	0.	0.	0.	0.	0.	0.	0.	0.
1101-1200	1.	0.	0.	0.	0.	0.	0.	0.	0.
1201-1300	5.	0.	0.	0.	0.	0.	0.	0.	0.
1301-1400	6.	1.	0.	0.	0.	0.	0.	0.	0.
1401-1500	8.	0.	0.	0.	0.	0.	0.	0.	0.
1501-1600	9.	2.	0.	0.	0.	0.	0.	0.	0.
1601-1700	15.	2.	0.	0.	0.	0.	0.	0.	0.
1701-1800	10.	1.	0.	0.	0.	0.	0.	0.	0.
1801-1900	20	3.	0.	0.	0.	0.	0.	0.	0.
1901-2000	8.	4.	1.	0.	0.	0.	0.	0.	0.
2001-2100	15.	1.	0.	0.	0.	0.	0.	0.	0.
2101-2200	12.	3.	1.	0.	0.	0.	0.	0.	0.
2201-2300	9.	1.	0.	0.	0.	0.	0.	0.	0.
2301-2400	14.	5.	1.	0.	0.	0.	0.	0.	0.
2401-2500	12.	1.	0.	0.	0.	0.	0.	0.	0.
2501-2600	11.	0.	1.	0.	0.	0.	0	0.	0.
2601-2700	5.	4.	0.	0.	0.	0.	0.	0.	0.
2701-2800	6.	4.	1.	0.	0.	0.	0.	0.	0.
2801-2900	6.	1.	0.	1.	0.	0.	0.	0.	0.
2901-3000	3.	2.	0.	0.	0.	0.	0.	0.	0.
3001-3100	4.	0.	0.	0.	0.	0.	0.	0.	0
3101-3200	2.	2.	0.	0.	0.	0.	0.	0.	0.
3201-3300	1.	2.	0.	0.	0.	0.	0.	0.	0.
3301-3400	3.	1.	0.	0.	0.	0.	0.	0.	0.
3401-3500	4.	0.	0.	0.	0.	0.	0.	0	0
3501-3600	1.	0.	0.	0.	0.	0.	0.	0.	0.
3601-3700	1.	1.	0.	0.	0.	0.	0.	0.	0.
3701-3800	2.	0.	0.	0.	0.	0.	0.	0.	0.
3801-3900	1.	0.	0.	0.	0.	0.	0.	0.	0.
3901-4000	0.	0.	1.	0.	0.	0.	0.	0.	0.
4001-4100	1.	1.	0.	0.	0.	0.	0.	0.	0.
4101-4200	0.	0.	0.	0.	0.	0.	0.	0.	0.
4201-4300	1.	0.	0.	0.	0.	0.	0.	0.	0
4301-4400	0.	0.	0.	0.	0.	0.	0.	0.	0.
4401-4500	0.	0.	0.	0.	0.	0.	0.	0.	0.
4501-4600	0.	0.	0.	0.	0.	0.	0.	0	0.
4601-4700	0.	0.	0.	0.	0.	0.	0.	0.	0.
4701-4800	0.	0.	0.	0.	0.	0.	0.	0.	0.
4801-4900	0.	0.	0.	0.	0.	0.	0.	0.	0
4901-5000	0.	0.	0.	0.	0.	0.	0.	0.	0.
SUM	235.0	44.	6.	1.	0.	0.	0.	0.	0.

Fig. A3—Example of Events Table, M60 Tank-Engine Replacement-Rate Output

Usage Interval, Miles	Vehicles Which Have Not Yet Experienced								
	1st Order Repl.	2nd Order Repl.	3rd Order Repl.	4th Order Repl.	5th Order Repl.	6th Order Repl.	7th Order Repl.	8th Order Repl.	9th Order Repl.
0-100	639.0	639.0	639.0	639.0	639.0	639.0	639.0	639.0	639.0
101-200	635.7	639.0	639.0	639.0	639.0	639.0	639.0	639.0	639.0
201-300	632.2	638.0	638.0	638.0	638.0	638.0	638.0	638.0	638.0
301-400	627.7	636.8	637.0	637.0	637.0	637.0	637.0	637.0	637.0
401-500	623.0	633.5	634.6	634.6	634.6	634.6	634.6	634.6	634.6
501-600	616.2	632.0	634.0	634.0	634.0	634.0	634.0	634.0	634.0
601-700	611.1	630.9	632.9	632.9	632.9	632.9	632.9	632.9	632.9
701-800	606.7	629.0	631.0	631.0	631.0	631.0	631.0	631.0	631.0
801-900	601.1	628.0	630.0	630.0	630.0	630.0	630.0	630.0	630.0
901-1000	598.0	628.0	630.0	630.0	630.0	630.0	630.0	630.0	630.0
1001-1100	591.9	626.8	628.8	628.8	628.8	628.8	628.8	628.8	628.8
1101-1200	589.3	626.0	628.0	628.0	628.0	628.0	628.0	628.0	628.0
1201-1300	583.1	623.9	625.9	625.9	625.9	625.9	625.9	625.9	625.9
1301-1400	573.7	619.4	621.7	621.7	621.7	621.7	621.7	621.7	621.7
1401-1500	564.4	616.2	619.2	619.2	619.2	619.2	619.2	619.2	619.2
1501-1600	553.4	610.3	614.6	614.6	614.6	614.6	614.6	614.6	614.6
1601-1700	538.6	603.0	608.7	608.7	608.7	608.7	608.7	608.7	608.7
1701-1800	510.1	594.7	602.6	602.6	602.6	602.6	602.6	602.6	602.6
1801-1900	500.0	586.3	596.3	596.3	596.3	596.3	596.3	596.3	596.3
1901-2000	478.7	570.0	580.9	581.1	581.1	581.1	581.1	581.1	581.1
2001-2100	457.6	551.2	562.6	562.6	562.6	562.6	562.6	562.6	562.6
2101-2200	433.1	530.7	544.1	544.1	544.1	544.1	544.1	544.1	544.1
2201-2300	405.8	500.4	512.5	513.5	513.5	513.5	513.5	513.5	513.5
2301-2400	359.2	448.7	459.8	460.9	460.9	460.9	460.9	460.9	460.9
2401-2500	309.3	395.5	407.0	409.0	409.0	409.0	409.0	409.0	409.0
2501-2600	255.9	339.1	350.6	353.1	353.1	353.1	353.1	353.1	353.1
2601-2700	221.0	298.5	309.8	312.4	312.4	312.4	312.4	312.4	312.4
2701-2800	189.2	258.0	271.4	273.7	273.7	273.7	273.7	273.7	273.7
2801-2900	163.9	224.3	239.3	240.4	240.4	240.4	240.4	240.4	240.4
2901-3000	147.4	202.8	215.8	215.8	215.8	215.8	215.8	215.8	215.8
3001-3100	130.4	179.8	189.1	189.1	189.1	189.1	189.1	189.1	189.1
3101-3200	114.6	155.3	162.4	162.4	162.4	162.4	162.4	162.4	162.4
3201-3300	95.6	128.2	134.5	134.5	134.5	134.5	134.5	134.5	134.5
3301-3400	77.9	104.2	109.3	109.3	109.3	109.3	109.3	109.3	109.3
3401-3500	70.7	92.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
3501-3600	60.2	82.2	86.5	86.5	86.5	86.5	86.5	86.5	86.5
3601-3700	52.1	70.8	75.2	75.2	75.2	75.2	75.2	75.2	75.2
3701-3800	43.0	57.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5
3801-3900	36.8	48.6	51.6	51.3	51.3	51.3	51.3	51.3	51.3
3901-4000	32.3	42.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
4001-4100	26.2	34.9	37.0	37.0	37.0	37.0	37.0	37.0	37.0
4101-4200	20.6	26.7	29.0	29.0	29.0	29.0	29.0	29.0	29.0
4201-4300	16.1	19.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4
4301-4400	10.6	14.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4
4401-4500	7.0	9.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6
4501-4600	6.1	8.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
4601-4700	2.2	4.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
4701-4800	0.	1.1	1.3	1.3	1.3	1.3	1.3	1.3	1.3
4801-4900	0.	0.	0.	0.	0.	0.	0.	0.	0.
4901-5000	0.	0.	0.	0.	0.	0.	0.	0.	0.
SUM	15418.7	17239.7	17484.9	17497.4	17497.4	17497.4	17497.4	17497.4	17497.4

Fig. A4—Example of Vehicle-Sample Density Table, M60 Tank-Engine Replacement-Rate Output

Usage Interval, Miles	$R_{s/e}$ Replacement Rates for Specific Orders of Replacement								
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order	8th Order	9th Order
0-100	0.003	0.	0.	0.	0.	0.	0.	0.	0.
101-200	0.003	0.	0.	0.	0.	0.	0.	0.	0.
201-300	0.006	0.	0.	0.	0.	0.	0.	0.	0.
301-400	0.006	0.002	0.	0.	0.	0.	0.	0.	0.
401-500	0.005	0.002	0.	0.	0.	0.	0.	0.	0.
501-600	0.011	0.	0.	0.	0.	0.	0.	0.	0.
601-700	0.002	0.	0.	0.	0.	0.	0.	0.	0.
701-800	0.007	0.	0.	0.	0.	0.	0.	0.	0.
801-900	0.005	0.	0.	0.	0.	0.	0.	0.	0.
901-1000	0.008	0.	0.	0.	0.	0.	0.	0.	0.
1001-1100	0.007	0.	0.	0.	0.	0.	0.	0.	0.
1101-1200	0.002	0.	0.	0.	0.	0.	0.	0.	0.
1201-1300	0.009	0.	0.	0.	0.	0.	0.	0.	0.
1301-1400	0.010	0.002	0.	0.	0.	0.	0.	0.	0.
1401-1500	0.014	0.	0.	0.	0.	0.	0.	0.	0.
1501-1600	0.016	0.003	0.	0.	0.	0.	0.	0.	0.
1601-1700	0.028	0.003	0.	0.	0.	0.	0.	0.	0.
1701-1800	0.020	0.002	0.	0.	0.	0.	0.	0.	0.
1801-1900	0.040	0.005	0.	0.	0.	0.	0.	0.	0.
1901-2000	0.017	0.007	0.002	0.	0.	0.	0.	0.	0.
2001-2100	0.033	0.002	0.	0.	0.	0.	0.	0.	0.
2101-2200	0.028	0.006	0.002	0.	0.	0.	0.	0.	0.
2201-2300	0.022	0.002	0.	0.	0.	0.	0.	0.	0.
2301-2400	0.039	0.011	0.002	0.	0.	0.	0.	0.	0.
2401-2500	0.039	0.003	0.	0.	0.	0.	0.	0.	0.
2501-2600	0.043	0.	0.003	0.	0.	0.	0.	0.	0.
2601-2700	0.023	0.013	0.	0.	0.	0.	0.	0.	0.
2701-2800	0.032	0.016	0.004	0.	0.	0.	0.	0.	0.
2801-2900	0.037	0.004	0.	0.004	0.	0.	0.	0.	0.
2901-3000	0.020	0.010	0.	0.	0.	0.	0.	0.	0.
3001-3100	0.031	0.	0.	0.	0.	0.	0.	0.	0.
3101-3200	0.017	0.013	0.	0.	0.	0.	0.	0.	0.
3201-3300	0.010	0.016	0.	0.	0.	0.	0.	0.	0.
3301-3400	0.039	0.010	0.	0.	0.	0.	0.	0.	0.
3401-3500	0.057	0.	0.	0.	0.	0.	0.	0.	0.
3501-3600	0.017	0.	0.	0.	0.	0.	0.	0.	0.
3601-3700	0.019	0.014	0.	0.	0.	0.	0.	0.	0.
3701-3800	0.047	0.	0.	0.	0.	0.	0.	0.	0.
3801-3900	0.027	0.	0.	0.	0.	0.	0.	0.	0.
3901-4000	0.	0.	0.023	0.	0.	0.	0.	0.	0.
4001-4100	0.038	0.029	0.	0.	0.	0.	0.	0.	0.
4101-4200	0.	0.	0.	0.	0.	0.	0.	0.	0.
4201-4300	0.062	0.	0.	0.	0.	0.	0.	0.	0.
4301-4400	0.	0.	0.	0.	0.	0.	0.	0.	0.
4401-4500	0.	0.	0.	0.	0.	0.	0.	0.	0.
4501-4600	0.	0.	0.	0.	0.	0.	0.	0.	0.
4601-4700	0.	0.	0.	0.	0.	0.	0.	0.	0.
4701-4800	0.	0.	0.	0.	0.	0.	0.	0.	0.
4801-4900	0.	0.	0.	0.	0.	0.	0.	0.	0.
4901-5000	0.	0.	0.	0.	0.	0.	0.	0.	0.

Fig. A5—Example of $R_{s/e}$ Replacement-Rate Table, M60 Tank-Engine Replacement-Rate Output

Usage Interval, Miles	R_s/o Replacement Rate for Specific Orders of Replacement									R_a/o Replacement Rate For All Orders Of Replacement
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order	8th Order	9th Order	
0-100	0.003	0.	0.	0.	0.	0.	0.	0.	0.	0.003
101-200	0.003	0.	0.	0.	0.	0.	0.	0.	0.	0.003
201-300	0.006	0.	0.	0.	0.	0.	0.	0.	0.	0.006
301-400	0.006	0.002	0.	0.	0.	0.	0.	0.	0.	0.008
401-500	0.005	0.002	0.	0.	0.	0.	0.	0.	0.	0.006
501-600	0.011	0.	0.	0.	0.	0.	0.	0.	0.	0.011
601-700	0.002	0.	0.	0.	0.	0.	0.	0.	0.	0.002
701-800	0.006	0.	0.	0.	0.	0.	0.	0.	0.	0.006
801-900	0.005	0.	0.	0.	0.	0.	0.	0.	0.	0.005
901-1000	0.008	0.	0.	0.	0.	0.	0.	0.	0.	0.008
1001-1100	0.006	0.	0.	0.	0.	0.	0.	0.	0.	0.006
1101-1200	0.002	0.	0.	0.	0.	0.	0.	0.	0.	0.002
1201-1300	0.008	0.	0.	0.	0.	0.	0.	0.	0.	0.008
1301-1400	0.010	0.002	0.	0.	0.	0.	0.	0.	0.	0.011
1401-1500	0.013	0.	0.	0.	0.	0.	0.	0.	0.	0.013
1501-1600	0.015	0.003	0.	0.	0.	0.	0.	0.	0.	0.018
1601-1700	0.025	0.003	0.	0.	0.	0.	0.	0.	0.	0.028
1701-1800	0.017	0.002	0.	0.	0.	0.	0.	0.	0.	0.018
1801-1900	0.034	0.005	0.	0.	0.	0.	0.	0.	0.	0.039
1901-2000	0.014	0.007	0.002	0.	0.	0.	0.	0.	0.	0.022
2001-2100	0.027	0.002	0.	0.	0.	0.	0.	0.	0.	0.028
2101-2200	0.022	0.006	0.002	0.	0.	0.	0.	0.	0.	0.029
2201-2300	0.018	0.002	0.	0.	0.	0.	0.	0.	0.	0.019
2301-2400	0.030	0.011	0.002	0.	0.	0.	0.	0.	0.	0.043
2401-2500	0.029	0.002	0.	0.	0.	0.	0.	0.	0.	0.032
2501-2600	0.031	0.	0.003	0.	0.	0.	0.	0.	0.	0.034
2601-2700	0.016	0.013	0.	0.	0.	0.	0.	0.	0.	0.029
2701-2800	0.022	0.015	0.004	0.	0.	0.	0.	0.	0.	0.040
2801-2900	0.025	0.004	0.	0.004	0.	0.	0.	0.	0.	0.033
2901-3000	0.014	0.009	0.	0.	0.	0.	0.	0.	0.	0.023
3001-3100	0.021	0.	0.	0.	0.	0.	0.	0.	0.	0.021
3101-3200	0.012	0.012	0.	0.	0.	0.	0.	0.	0.	0.025
3201-3300	0.007	0.015	0.	0.	0.	0.	0.	0.	0.	0.022
3301-3400	0.027	0.009	0.	0.	0.	0.	0.	0.	0.	0.037
3401-3500	0.041	0.	0.	0.	0.	0.	0.	0.	0.	0.040
3501-3600	0.012	0.	0.	0.	0.	0.	0.	0.	0.	0.012
3601-3700	0.013	0.013	0.	0.	0.	0.	0.	0.	0.	0.027
3701-3800	0.033	0.	0.	0.	0.	0.	0.	0.	0.	0.033
3801-3900	0.019	0.	0.	0.	0.	0.	0.	0.	0.	0.019
3901-4000	0.	0.	0.023	0.	0.	0.	0.	0.	0.	0.023
4001-4100	0.027	0.027	0.	0.	0.	0.	0.	0.	0.	0.054
4101-4200	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4201-4300	0.049	0.	0.	0.	0.	0.	0.	0.	0.	0.049
4301-4400	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4401-4500	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4501-4600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4601-4700	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4701-4800	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4801-4900	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4901-5000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Fig. A6—Example of R_s/o and R_a/o Replacement-Rates Table, M60 Tank-Engine Replacement-Rate Output

Usage Interval, Miles	Cumulative $R_{s/o}$ Replacement Rate for All Orders of Replacement									Cumulative $R_{a/o}$ Replacement Rate For All Orders Of Replacements
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order	8th Order	9th Order	
0-100	0.003	0.	0.	0.	0.	0.	0.	0.	0.	0.003
101-200	0.006	0.	0.	0.	0.	0.	0.	0.	0.	0.006
201-300	0.012	0.	0.	0.	0.	0.	0.	0.	0.	0.012
301-400	0.018	0.002	0.	0.	0.	0.	0.	0.	0.	0.020
401-500	0.023	0.004	0.	0.	0.	0.	0.	0.	0.	0.026
501-600	0.034	0.004	0.	0.	0.	0.	0.	0.	0.	0.037
601-700	0.036	0.004	0.	0.	0.	0.	0.	0.	0.	0.039
701-800	0.042	0.004	0.	0.	0.	0.	0.	0.	0.	0.045
801-900	0.047	0.004	0.	0.	0.	0.	0.	0.	0.	0.050
901-1000	0.055	0.004	0.	0.	0.	0.	0.	0.	0.	0.058
1001-1100	0.061	0.004	0.	0.	0.	0.	0.	0.	0.	0.064
1101-1200	0.063	0.004	0.	0.	0.	0.	0.	0.	0.	0.066
1201-1300	0.071	0.004	0.	0.	0.	0.	0.	0.	0.	0.074
1301-1400	0.081	0.006	0.	0.	0.	0.	0.	0.	0.	0.085
1401-1500	0.094	0.006	0.	0.	0.	0.	0.	0.	0.	0.098
1501-1600	0.107	0.009	0.	0.	0.	0.	0.	0.	0.	0.116
1601-1700	0.134	0.012	0.	0.	0.	0.	0.	0.	0.	0.144
1701-1800	0.151	0.014	0.	0.	0.	0.	0.	0.	0.	0.162
1801-1900	0.185	0.019	0.	0.	0.	0.	0.	0.	0.	0.201
1901-2000	0.199	0.026	0.002	0.	0.	0.	0.	0.	0.	0.223
2001-2100	0.226	0.028	0.002	0.	0.	0.	0.	0.	0.	0.251
2101-2200	0.248	0.034	0.004	0.	0.	0.	0.	0.	0.	0.280
2201-2300	0.266	0.036	0.004	0.	0.	0.	0.	0.	0.	0.299
2301-2400	0.296	0.047	0.006	0.	0.	0.	0.	0.	0.	0.342
2401-2500	0.325	0.049	0.006	0.	0.	0.	0.	0.	0.	0.374
2501-2600	0.356	0.049	0.009	0.	0.	0.	0.	0.	0.	0.408
2601-2700	0.372	0.062	0.009	0.	0.	0.	0.	0.	0.	0.437
2701-2800	0.394	0.077	0.013	0.	0.	0.	0.	0.	0.	0.477
2801-2900	0.419	0.081	0.013	0.004	0.	0.	0.	0.	0.	0.510
2901-3000	0.433	0.090	0.013	0.004	0.	0.	0.	0.	0.	0.533
3001-3100	0.454	0.090	0.013	0.004	0.	0.	0.	0.	0.	0.554
3101-3200	0.466	0.102	0.013	0.004	0.	0.	0.	0.	0.	0.579
3201-3300	0.473	0.117	0.013	0.004	0.	0.	0.	0.	0.	0.601
3301-3400	0.500	0.126	0.013	0.004	0.	0.	0.	0.	0.	0.638
3401-3500	0.541	0.126	0.013	0.004	0.	0.	0.	0.	0.	0.678
3501-3600	0.553	0.126	0.013	0.004	0.	0.	0.	0.	0.	0.690
3601-3700	0.566	0.139	0.013	0.004	0.	0.	0.	0.	0.	0.717
3701-3800	0.599	0.139	0.013	0.004	0.	0.	0.	0.	0.	0.750
3801-3900	0.618	0.139	0.013	0.004	0.	0.	0.	0.	0.	0.769
3901-4000	0.618	0.139	0.036	0.004	0.	0.	0.	0.	0.	0.792
4001-4100	0.645	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.846
4101-4200	0.645	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.846
4201-4300	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4301-4400	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4401-4500	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4501-4600	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4601-4700	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4701-4800	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4801-4900	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895
4901-5000	0.694	0.166	0.036	0.004	0.	0.	0.	0.	0.	0.895

Fig. A7—Example of Cumulative $R_{s/o}$ and $R_{a/o}$ Replacement-Rates Table, M60 Tank-Engine Replacement-Rate Output

DETAILED DESCRIPTION

The Events Rates Routine is programmed in Fortran IV for the IBM 7040 computer. It was used to analyze replacement data gathered by RAC analysts for RAC-T-460.[1] Minor modifications would be required in order to process TAERS data. The routine has two phases: the first selects desired basic data and writes them on a file in the format required by the second phase; the second phase computes rates.

Phase I

As shown in Fig. A8, for Phase I the computer routine selects the desired subsample(s) of equipment from the equipment file and certain types of events from the events file. The blackened portions of Fig. A8 show the final results

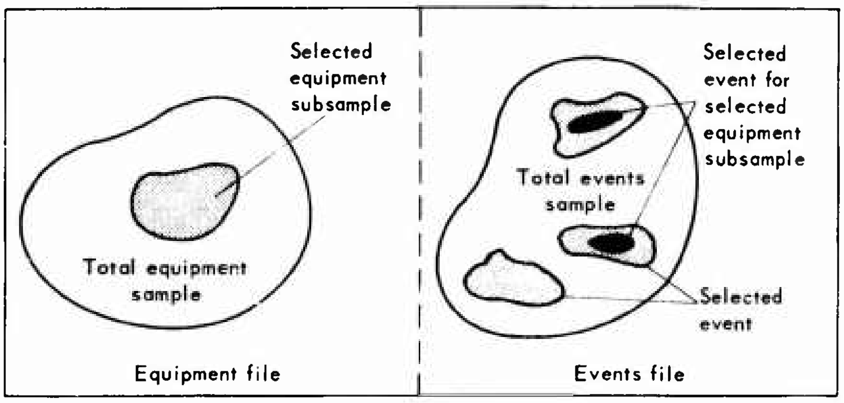


Fig. A8—Illustration of Phase I Selection Capability

of the double selection process: certain types of events occurring in the selected equipment subsample. Figure A9 shows schematically the selection process as it is performed by the computer.

Input: Phase I of the rates calculation requires two kinds of input: basic data and control data.

Basic data: Basic data are in two files on separate magnetic tapes: an events file and an equipment file.

(a) Events file contains one record per block, 61 BCD characters per record, in ascending equipment number within ascending event number overall, or if the file is partitioned, within partition. The last record of the equipment sequence in the last event of the file or of a partition must be an ENDE record. The record format of basic events data is shown in Table A1. The information in parentheses represents the application of the format to RAC-T-460[1] data.

The first record of the events file is a label of the format shown in Table A2.

In addition to the label and the events data records, there is a record called ENDE for at least each troop unit in which equipment was sampled. The format of ENDE is shown in the accompanying tabulation.

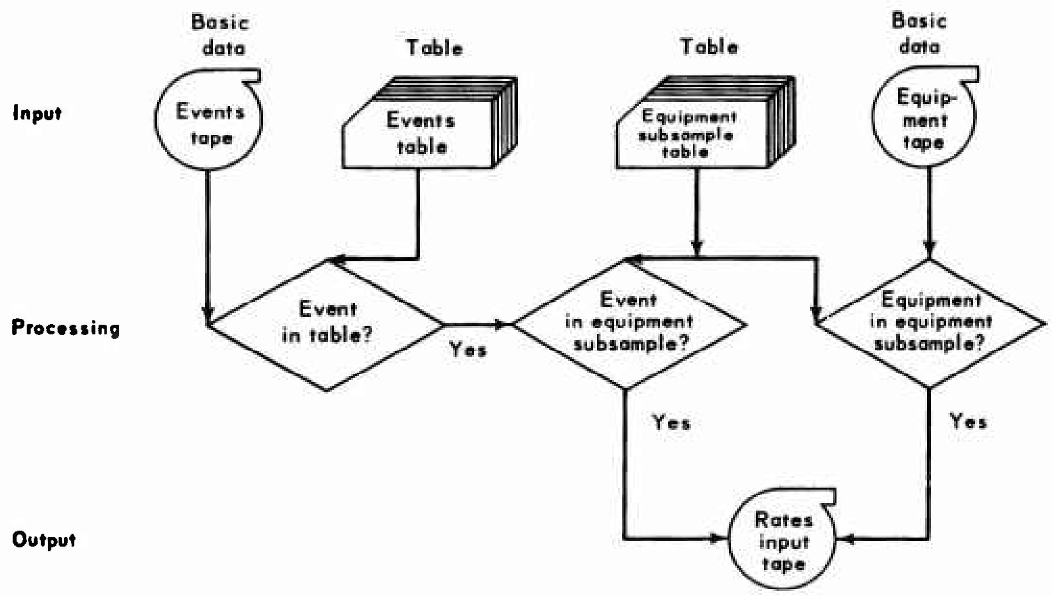


Fig. A9—Flow Chart Demonstrating Computer Selection of Equipment Subsample and Type of Event from Equipment and Events Files

TABLE A1

Record Format of Events Data

Element	Fortran name	Card columns
Equipment type code (tank or APC)	—	2
Unit code (Bn)	UN	3, 4
Equipment identification number (last 4 digits of USA registration number)	RN	8–11
Equipment age at event (miles)	AEM	27–31
Equipment age at event[a] (days)	AED	32–35
Event type code (repair, adjustment, or replacement)	—	44
Event order (first, second, third, etc.)	—	45
Quantity of components involved in the event	Q	46–48
Component identification number (FSN)	NFSN	49–59
Component identification number[b] (RAC No.)[c]	PN	60, 61

[a]Two age measures are permitted; the second (AED) interpreted as chronological age in the assignment of order number in step 3 of Phase I processing.

[b]Two component identification numbers are permitted.

[c]A number is assigned to each part name and may represent more than one FSN.

TABLE A2

Record Format of Events File Label

Element	Card columns
"L"	1
"00"	3, 4
"0000"	8–11
Date file was made	12–17
Day	12, 13
Month	14, 15
Year	16, 17
Equipment type code	18
Data type code 2 for events	19
Data description	20–43
0's	49–61

Element	Fortran name	Card columns
Unit code	UN	3-4
"ENDE"	ENDE	8-11

(b) The equipment file contains one record per block, 60 BCD characters per record in ascending equipment number sequence overall, or if the file is partitioned, within partition. The last record of a sequence must be ENDV. The record format of basic equipment data is shown in Table A3.

TABLE A3

Record Format of Basic Equipment Data

Element	Fortran name	Card columns
Equipment type code	—	2
Unit code	UN	3, 4
Equipment identification number	RN	8–11
Equipment age when last seen in sample	AEM	27–31
Equipment age when last seen in sample[a]	AED	32–35
Equipment age when first seen in sample	ABM	50–54
Equipment age when first seen in sample[a]	ABD	55–58

[a]Two age measures are permitted.

The first record of the equipment file is a label of the format of the events file label (Table A2) except that position 19 contains a "1" for equipment; there are also the same set of ENDV records as there are ENDE records for the events file.

Control data. The control data for Phase I specify program control words and also specify for each job the events and the equipment subsample (if any) to be selected from the basic data files. Each job is composed of at least two

data blocks. The first data block in each job is the equipment sample or subsample. Each remaining data block in the job is a specific event for which a rate is to be computed. The control data are in punched cards and are shown in Table A4.

Phase I control cards are used in the following sequence:

1 Ends, match, blockstops
2 Events table, ≤ 60 cards
3 SWSUB
4 SWSEQ
5 SAMP
6 SWSUBE
7 SWRW
8 NBLK
9 Subsample table, ≤ 500 cards
10 VBLK
11 M

Only one card 1 is used per run; a set of cards 2 to 11 is used for each job.

Processing. The processing of Phase I consists of three steps: (a) reading control data, (b) transferring selected equipment records from the basic equipment file to the output file, and (c) transferring selected event records from the basic events file to the output file.

Step 1 is performed only once per job; steps 2 and 3 are performed once for each event in the job. In the performing of step 3, event-order numbers are assigned on the basis of the chronology of the events: the first observed event is always numbered 1; subsequent events are numbered consecutively 2, 3, ..., up to 9; events of order greater than 9 are ignored. Chronology is determined from the second of the two allowed age measures (see Table A1).

Output. The output file is a magnetic tape containing the selected events and equipment records in the record formats described under the subsection "Input" for event file and equipment file, except that the equipment number is now a 5-character field (the additional character is a 0 and appears in position 7 of the record). The tape format is shown in Fig. A10. The accompanying tabulation shows the format for nondata records used in the tape.

Record	Positions
V; E; Y; Z	1
SAMP; event description	1–54
Stop 1; 2	7–11

Phase II

Phase II computes rates as a function of equipment age for the events it receives from Phase I. Phase II can compute rates for two kinds of events from the same sets of events data: a job-order rate and a replacement rate. The two kinds may be different if the component in question exists on the equipment in numbers >1; in this circumstance a job order may involve the replacement of 0 to n (if there are n components on the vehicle). A rate may also be computed for two different age measures. Hence, for a set of events data, four different rates versus age calculations can be made. The size of the unit age

TABLE A4

Control Data for Phase I

Data	Fortran name	Description	Codes	Characters: Type[a]	Characters: Quantity	Card number	Card columns
Ends	ENDE ENDV ENDT	Words identifying end of files and subsample table		A	4	1	4–7; 11–14; 18–21
Match	MA	Value assumed by the parameter MATCH when a match occurs in a comparison using MATCH to indicate its outcome		A	4	1	25–28
No match	NOMA	Value assumed by the parameter MATCH when no match occurs in a comparison using MATCH to indicate its outcome		A	4	1	32–35
Block stop 1	BLKS1	Word used to indicate end of an event subfile in Phase I output		A	5	1	38–42
Block stop 2	BLKS2	Word used to indicate end of vehicle subfile in Phase I output		A	5	1	45–49
Events table		List of events to be selected from basic data					
Part name	BLKN			A	18	2	1–18
Part name abbreviation	BLKC			A	12	2	21–32
"1"	VF11			N	1	2	35
Number of parts per equipment	VFQ1			N	3	2	38–40
Begin sample code	BCI	Indicates whether data for the event was available from time of issue for all equipment in the sample or subsample or only from times in life later than issue for some vehicles	1 Data from time of issue 2 Data from subsequent time	N	1	2	43
First part of part number	NFSN1			N	5	2	46–50
Second part of part number	NFSN2			N	6	2	52–57
Other part number	PN			N	2	2	60–61
The last card of the events table is "9"				N	1	—	35

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Subsample switch	SWSUB	Switch indicating whether a subsample is to be formed on the basis of unit number, equipment number, or not at all	1 Unit number 2 Equipment number 3 No subsample to be formed	N	1	3	11
Sequence switch	SWSEQ	Switch indicating whether the files are in subsample selection parameter sequence (used to permit taking advantage of increased efficiency of selection possible when the files are in sequence)	1 In sequence 2 Not in sequence	N	1	4	11
Sample	SAMP	Sample or subsample description for the job		A	54	5	11–64
Events selection switch	SWSUBE	Switch indicating which event identification number is to be used for event selection	1 Use event number in positions 60, 61 2 Use event number in positions 49–59	N	1	6	11
Rewind switch	SWRW	Switch indicating whether the basic data tapes are to be rewound after the job	1 Rewind 2 No rewind	N	1	7	11
Basic files formats	NBLK	Indicates whether the basic files are partitioned into subsamples	1 Unpartitioned 2 Partitioned	N	1	8	11
Subsample table	SPART	List of unit numbers or equipment numbers specifying the subsample to be selected from the basic data		A	4	9	11–14[b]
Equipment subfile name	VBLK	Identification of equipment type and an abbreviated statement of the sample description	"V"	A	1	10	11
			Equipment	A	18	10	14–31
			Sample abbreviation	A	12	10	34–45
Job control	M	Indicates whether another job follows	98 Another job follows, 99 Last job	N	2	11	11–12

[a] A, alphameric; N, numeric.
[b] The last card of the table contains end of table (ENDT) in 11 to 14.

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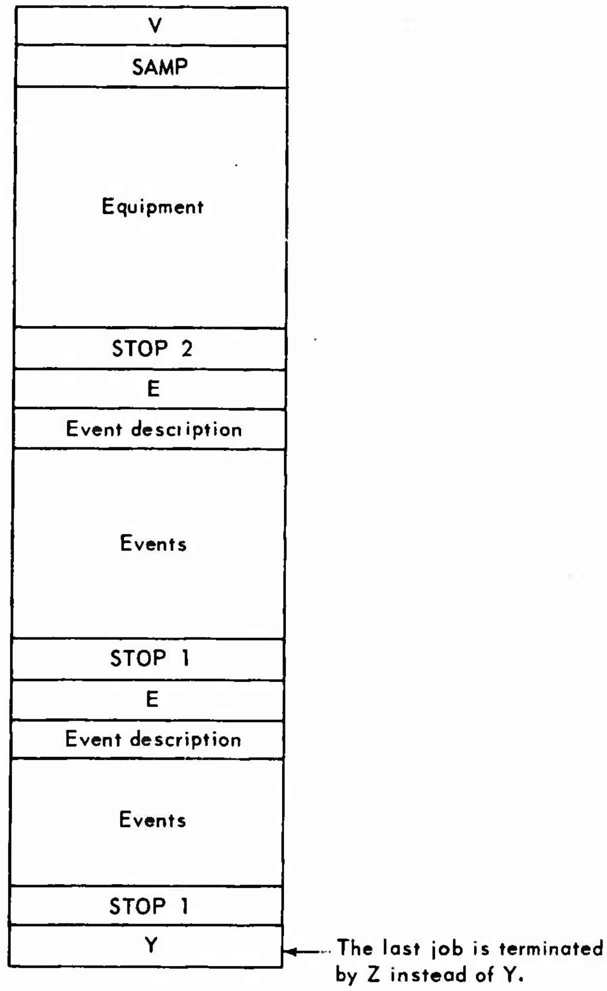

Fig. A10—Phase I Output Tape Layout for One Job

interval may be anything >0. Phase II computes only one kind of rate for one kind of age measure for one unit age interval size per pass oi the input tape; however, any number of passes of the tape may be made in a single Phase II run, and any combination of the three rate-type variables may be changed between passes.

Input. Phase II takes two kinds of input: the output of Phase I (described in the preceding section) and control data.

The control data for Phase II specifies program control words; states the study number, program name, and date; and defines the maximum number of age intervals to be considered, the age-interval size, the type of age measure to be used, the kind of event (job order or quantity), and Fortran format statements for reading the input appropriate to the specified kinds of rate and age measure. The control data are in punched cards as shown in Table A5.

The first pass requires control cards 1 to 11, in sequence. To make another pass with changed event type only, cards numbered 12, 9, 10, and 11—in

TABLE A5

Control Data for Phase II

Data	Fortran name	Description	Codes	Characters		Card number	Card columns
				Type[a]	Quantity		
Stops	STOP1	STOP1 is the word in the equipment number field indicating the end of the event		A	5	1	11–15
	STOP2	STOP2 is the word in the equipment number field indicating the end of the equipment sample or subsample		A	5	1	16–20
Study number	STUDY	RAC study number		A	6	2	11–16
Program name	PROG	Name of computer program		A	36	2	17–52
Maximum age interval number	YMAX	Age interval number containing the greatest age that will be considered in the calculation; events occurring in later age intervals are ignored (usually set at 50 to keep an output matrix on one page)		N	3	2	53–55
	ZMAX			N	3	2	56–58
Date	DATE	Day, month, and year of calculation		A	2	3	11–12
				A	2	3	13–14
				A	2	3	15–16
Abbreviated general info	GRUN	Abbreviated statement of study, program name, and date (printed at top of output pages)		A	24	4	11–34
Data type definitions	E	Definition of control records on the input tape that designate whether the data following are events data or equipment data, and whether another job follows the one just ended or there are no more jobs	E events	A	1	5	11
	V		V equipment	A	1	5	22
	Y		Y new job coming	A	1	5	44
	Z		Z no more jobs	A	1	5	44
Run control definitions	NEWS	Words that tell whether another pass of the input tape is to be made, and if one is, whether it will be with a new age segment ("and a new event type" is an option available here) or just a new event type		A	4	6	21–24
	NEWR			A	4	6	31–34
Age segment	S	Age interval size and name of type of age measure		N	5	7	11–15
	STYP			A	6	7	16–21
Age format	FMTV	Fortran format statement for reading age field containing age in the specified measure		A	30	8	11–40
Event type	ETYP	Designates event type as "job order" or "quantity"	1 JO	A	6	9	11–16
			2 Q	N	1	9	19
Event description format	FMTE1	Fortran format statement for reading event description		A	30	10	11–40
Event format	FMTE2	Fortran format statement for reading events		A	30	11	11–40
Run control	NFLD	Word telling the program whether to make another pass and if so what parameters to change	NEWS new age segment NEWR new event type ENDJ end of run	A	4	12	8–11

[a]A, alphameric; N, numeric.

that sequence—are placed after card 11 of the preceding pass. To make another pass with changed event type and/or changed age segments, cards numbered 12, 7, 8, 9, 10, and 11—in that sequence—are placed after card 11 of the preceding pass. To end the run, card 12, containing ENDJ, is placed after card 11 of what is desired to be the last pass.

Processing. The processing of Phase II occurs in two distinct steps as shown in Fig. A11. In Step 1, events and equipment exposures to event occurrences are counted for each age interval of equipment exposure. In Step 2 these counts are arithmetically manipulated to produce various types of events rates.

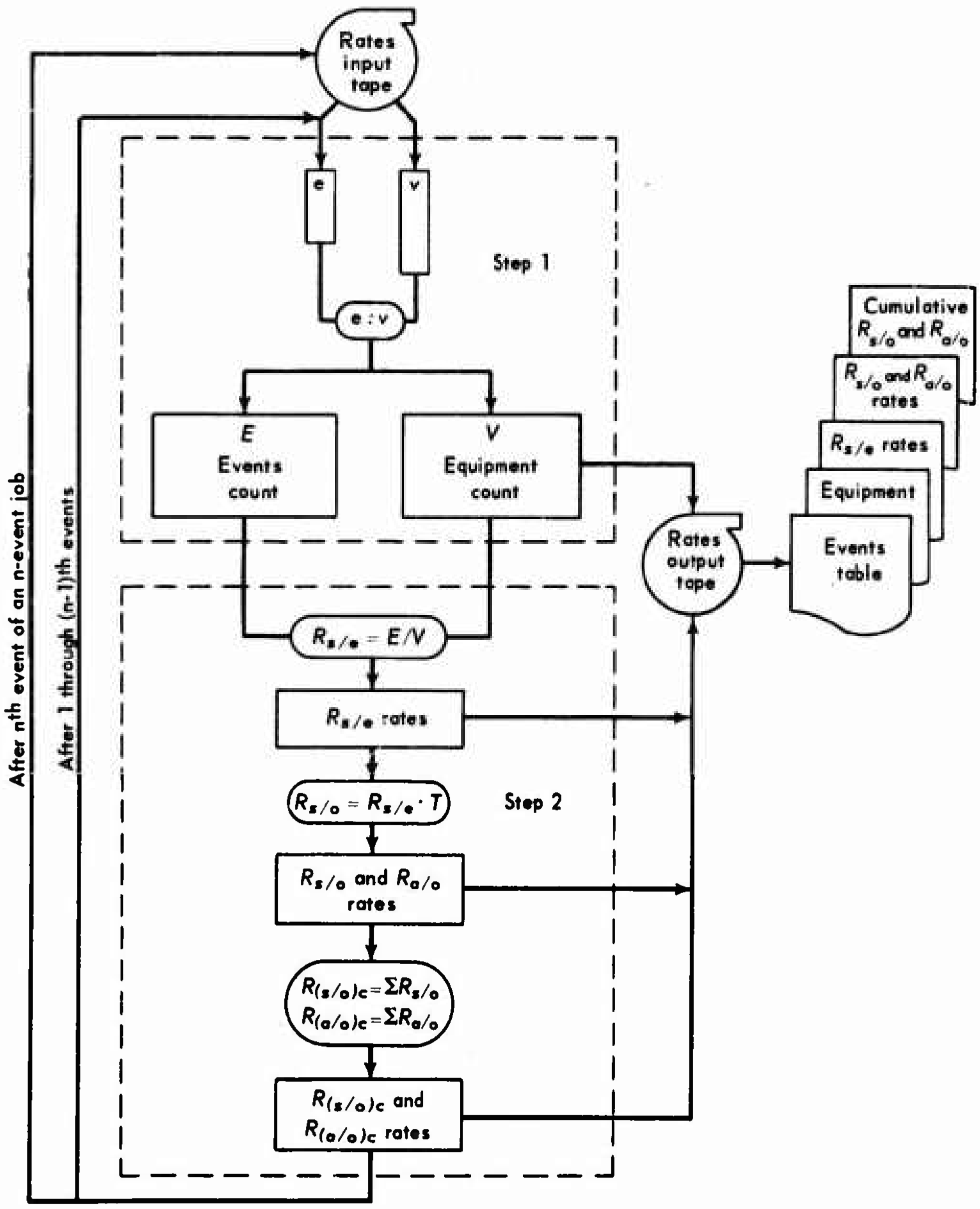

Fig. A11—Flow Chart Outline of Phase II

Step 1. Step 1 operates by first reading into core memory the complete ($\leq$ 1000 records) equipment sample or subsample file for the job. It then reads in the events for which the rate is to be calculated for the sample or subsample. Having read in all the data for an event, it counts events E_{ij} and equipment exposures V_{ij} for each age interval j and for each failure order i, in the following manner:

(1) An event record (equipment number N_e, equipment age when event occurred A_e, and event order I) is noted.

(2) An equipment record (equipment number N_υ, equipment age A_υ when last observed in sample, and equipment age B_υ when first seen in sample) is noted.

(a) If $N_\upsilon < N_e$ the item is regarded as having experienced none of the events in question, and the equipment counts V_{ij} are all augmented by 1 for i = 1, ..., 9, and $j = J_1, \ldots J_2$,
where

$$J_1 = (B_\upsilon/s) + 1 \text{ truncated to nearest lower integer,}$$

$$J_2 = (A_\upsilon/s) \text{ truncated to nearest lower integer,}$$

and by

$$[J_1 - (B_\upsilon/s)] \text{ for } j = J_1 - 1,$$

and by

$$[A_\upsilon/s - J_2] \text{ for } j = J_2 + 1;$$

the process continues at 2 with the next equipment record.

(b) If $N_\upsilon = N_e$ the event count E_{ij} for $i = I$, $j = J_3$, where $J_3 = (A_e/s) + 1$ truncated to nearest lower integer, is augmented by 1 (unless $A_e > A_\upsilon$, in which case the event is ignored), and the equipment count V_{ij} for $i = I$, $j = J_1, \ldots, J_3$ is augmented by 1, and for $j = J_1 - 1$ by $[J_1 - (B_\upsilon/s)]$, and for $j = J_3 + 1$ by $[(A_e/s) - J_3]$; now the next event is read, the event and equipment exposure are counted as just described if the event occurred on the present item; when it did not, 2a is executed except that i is limited to $i >$ highest order event observed for the item.

(c) If $N_\upsilon > N_e$, the event is regarded as having occurred to an item not in the sample and is ignored; the next event is read, and the process beginning at 2a (not 2) is repeated.

Step 2. Step 2 operates on the counts made in step 1. The $R_{s/e}$ rates are computed directly from

$$R_{(s/e)ij} = E_{ij}/V_{ij},$$

the $R_{s/o}$ rates are computed by

$$R_{(s/o)ij} = K_{ij}\, T_{ij},$$

which is specified by

$$T_{i1} = 1$$

$$T_{in} = 1 - \sum_{j=1}^{n-1} R_{ij},$$

and $R_{a/o}$ rates are computed by

$$R_{(a/o)j} = \sum_i R_{(s/o)ij};$$

the cumulative rates are simply

$$R_{(s/o)ijc} = \sum_{k=1}^{j} R_{(s/o)ik}$$

and

$$R_{(a/o)jc} = \sum_{k=1}^{j} R_{(a/o)k}.$$

Output. The output of Phase II is a magnetic tape from which a six-page listing is printed for each part analyzed according to a given type of event and a usage interval of a given type and size. The format and a sample of the printed output are shown in Figs. A2 to A7 in the first section of this appendix.

Three notes on interpretation of out put are in order:

(a) Zeros are printed when the rate is 0 and when no equipment exposure occurred during the interval. The former meaning applies only if there was equipment exposure during the usage interval.

(b) Event order numbers have their intended meanings only when the complete history of the event in the sample is known (i.e., only when all events the sample has experienced since issue are known). This is detectable by examining the equipment count (V) page and knowing the sample population: if V_{i1} is equal to the sample population for $i > 2$ and if V_{ij} decreases monotonically with increasing j, the basic data for the sample is regarded as containing a complete history of the event. If neither or only one of these conditions holds, the basic data for the sample are regarded as not containing a complete history of the event. $R_{a/o}$ is a valid rate for events with incomplete histories. Cumulative $R_{a/o}$ is also valid if the age intervals in which the sample is present are contiguous and begin at age 0.

(c) The meaning of event order is also obscured in replacement rates for parts that are present on the equipment in numbers >1. A replacement job order may not involve the replacement of all of them. In this situation the $R_{a/o}$ rate is valid; as in the case of incomplete equipment histories the cumulative $R_{a/o}$ rate is valid only if the age intervals in which the sample is present are contiguous and begin at age 0.

Appendix B

REPLACEMENT RATES FOR SELECTED M60 TANK AND M113 APC REPAIR PARTS

Tables

This appendix presents tabular summaries of the $R_{a/o}$ replacement-rate information processed by the computer routine described in App A.

Tables in the first half of this appendix provide mortality rates for M60 tanks; tables in the latter half deal with M113 APCs. Table B1, the first of a group (Tables B1 to B45) dealing with M60 tanks, presents the official nomenclature of each M60 tank repair part studied and lists all the FSNs that were included in calculating the number of events that occurred for each repair part. Table B46 gives similar information for M113 APCs. Replacement-rate data for M60 tanks are provided in Tables B2 to B46 and for M113 APCs in Tables B47 to B90. In the titles of these tables the official nomenclatures of the repair parts have been paraphrased in order to make the titles easier to read.

The replacement rates shown in the last two columns of Tables B2 to B45 and B47 to B90 represent both the principal output of the computer routine described in App A and the principal input to the Least Squares Statistical Routine discussed in App C. Although the output from the first routine could be input directly into the second routine without intermediate printouts, the unsmoothed mortality data obtained from the Events Rates Program are frequently of considerable interest in reliability and maintainability studies. For this reason—and in order to illustrate the kinds of analyses conducted during the development of the forecasting methodology—replacement-rate information is presented in considerable detail in this appendix.

Various types of replacement-rate data are provided:

(a) $R_{a/o}$ rates presented are based on two usage measures, miles of operation and months of service. For the selected USAREUR M60 tank and M113 APC repair parts analyzed, the tables showing rates based on 100-mile usage intervals are immediately followed by tables based on 1-month usage intervals.

(b) Each App B mortality table contains two types of $R_{a/o}$ rates, one based on the quantity of parts replaced and a second based on the number of maintenance actions. Previous sections of this paper have emphasized rates calculated on the former basis because supply analysts are more concerned with the number of parts replaced than with the number of times parts are replaced. The $R_{a/o}$ rates indicating the frequency of maintenance actions have been included because of their importance in vehicle reliability analysis. When only one repair part of a given type is used on each vehicle per maintenance action, the two rates are identical.

(c) In order to illustrate the calculation of rates at different organizational levels, rate tables were included for selected M60 tank repair parts at division and battalion level and for selected M113 APC repair parts at division level. To offset the marked decrease in vehicle sample size at the lower organizational levels it is frequently desirable to increase the length of the usage interval. For comparative purposes Tables B41 to B45 and B79 to B90 present $R_{a/o}$ rates computed on the basis of each 100 miles and each 500 miles of operation.

M60 TANKS

TABLE B1

FSNs of M60 Tank Repair Parts Studied

Official nomenclature of part	FSN	Official nomenclature of part	FSN
Arm assemblies, road and idler wheel	2530-678-3147	Pump, metering, fuel injection	2910-473-8003
	2530-678-3148		2910-783-7063
	2530-678-3149	Relay, starter, modification kit	2920-897-6732
	2530-678-3150	Shock absorber, direct action	2540-690-2756
	2530-678-3151	Shoe assembly, rubber track	2530-337-6969
	2530-678-3152	Sprocket, final drive	2530-318-0229
	2530-678-3157	Starter assembly, engine electrical	2920-678-4679
Battery, storage	6140-057-2554		2920-710-1752
Engine assembly	2815-679-4963		2920-796-2616
	2815-856-4996	Transmission assembly	2520-333-3522
Generator assembly, engine accessory	2920-607-2623		2520-649-8542
	2920-786-1175		2520-670-5379
	2920-830-6660		2520-774-8333
Hub, sprocket, final drive	2530-736-4134	Traverse gear box assembly	2520-621-9567
Link assembly, track adjusting	2530-602-5738	Turbosupercharger, engine assembly	2990-678-4677
	2530-602-5739		2990-678-4678
Nozzle, fuel injector	2910-707-8784	Wheels, road and compensating idler	2530-678-4133
			2530-784-9292

IN USAREUR, BASED ON MILES OF OPERATION

TABLE B2

Replacement Rates for Road and Idler Wheel Arms on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	0	0	0.000	0.000
301-400	341.3	1	1	0.003	0.003
401-500	370.9	0	0	0.000	0.000
501-600	414.0	0	0	0.000	0.000
601-700	469.9	0	0	0.000	0.000
701-800	152.5	2	2	0.004	0.004
801-900	546.2	1	1	0.002	0.002
901-1000	567.0	2	2	0.004	0.004
1001-1100	579.6	1	1	0.002	0.002
1101-1200	593.0	4	4	0.007	0.007
1201-1300	598.4	1	1	0.002	0.002
1301-1400	603.8	2	2	0.003	0.003
1401-1500	607.7	0	0	0.000	0.000
1501-1600	607.0	2	2	0.003	0.003
1601-1700	607.4	1	2	0.002	0.003
1701-1800	602.6	1	1	0.002	0.002
1801-1900	596.3	3	3	0.005	0.005
1901-2000	581.1	5	7	0.009	0.012
2001-2100	562.6	1	1	0.002	0.002
2101-2200	544.1	4	5	0.007	0.009
2201-2300	513.5	3	3	0.006	0.006
2301-2400	460.9	0	0	0.000	0.000
2401-2500	409.0	4	4	0.010	0.010
2501-2600	353.1	2	2	0.006	0.006
2601-2700	312.4	4	4	0.013	0.013
2701-2800	273.7	1	12	0.004	0.044
2801-2900	240.4	0	0	0.000	0.000
2901-3000	215.8	1	1	0.005	0.005
3001-3100	189.1	1	1	0.005	0.005

TABLE B3

Replacement Rates for Batteries on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	2	2	0.006	0.006
201-300	331.2	2	2	0.006	0.006
301-400	341.3	1	1	0.003	0.003
401-500	370.9	3	4	0.008	0.011
501-600	414.0	2	12	0.005	0.029
601-700	469.9	1	1	0.002	0.002
701-800	512.5	0	0	0.000	0.000
801-900	546.2	1	1	0.002	0.002
901-1000	567.0	3	4	0.005	0.007
1001-1100	579.6	2	3	0.003	0.005
1101-1200	593.0	1	1	0.002	0.003
1201-1300	598.4	4	10	0.007	0.017
1301-1400	603.8	0	0	0.000	0.000
1401-1500	607.7	2	5	0.003	0.008
1501-1600	607.0	3	4	0.005	0.007
1601-1700	607.4	2	6	0.003	0.010
1701-1800	602.6	2	2	0.003	0.003
1801-1900	596.3	1	1	0.002	0.002
1901-2000	581.1	4	5	0.007	0.009
2001-2100	562.6	5	12	0.009	0.021
2101-2200	544.1	3	8	0.006	0.015
2201-2300	513.5	1	2	0.002	0.004
2301-2400	460.9	3	9	0.007	0.020
2401-2500	409.0	1	1	0.002	0.002
2501-2600	353.1	0	0	0.000	0.000
2601-2700	312.4	1	2	0.003	0.006
2701-2800	273.7	3	15	0.011	0.055
2801-2900	240.4	3	3	0.012	0.012
2901-3000	215.8	0	0	0.000	0.000
3001-3100	189.1	1	1	0.005	0.005

TABLE B4

Replacement Rates for Engines on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{o/o}$ replacement rate for: Maintenance actions	$R_{o/o}$ replacement rate for: Parts replaced
0-100	639.0	2	2	0.003	0.003
101-200	639.0	2	2	0.003	0.003
201-300	638.0	4	4	0.006	0.006
301-400	637.0	5	5	0.008	0.008
401-500	634.6	4	4	0.006	0.006
501-600	634.0	7	7	0.011	0.011
601-700	632.9	1	1	0.002	0.002
701-800	631.0	4	4	0.006	0.006
801-900	630.0	3	3	0.005	0.005
901-1000	630.0	5	5	0.008	0.008
1001-1100	628.8	4	4	0.006	0.006
1101-1200	628.0	1	1	0.002	0.002
1201-1300	625.9	5	5	0.008	0.008
1301-1400	621.7	7	7	0.011	0.011
1401-1500	619.2	8	8	0.013	0.013
1501-1600	614.6	11	11	0.018	0.018
1601-1700	608.7	17	17	0.028	0.028
1701-1800	602.6	11	11	0.018	0.018
1801-1900	596.3	23	23	0.039	0.039
1901-2000	581.1	13	13	0.022	0.022
2001-2100	562.6	16	16	0.028	0.028
2101-2200	544.1	16	16	0.029	0.029
2201-2300	513.5	10	10	0.019	0.019
2301-2400	460.9	20	20	0.043	0.043
2401-2500	409.0	13	13	0.032	0.032
2501-2600	353.1	12	12	0.034	0.034
2601-2700	312.4	9	9	0.029	0.029
2701-2800	273.7	11	11	0.040	0.040
2801-2900	240.4	8	8	0.033	0.033
2901-3000	215.8	5	5	0.023	0.023
3001-3100	189.1	4	4	0.021	0.021
3101-3200	162.4	4	4	0.025	0.025
3201-3300	134.5	3	3	0.022	0.022
3301-3400	109.3	4	4	0.037	0.037
3401-3500	97.6	4	4	0.041	0.041
3501-3600	86.5	1	1	0.012	0.012
3601-3700	75.2	2	2	0.027	0.027
3701-3800	61.5	2	2	0.033	0.033
3801-3900	51.3	1	1	0.019	0.019
3901-4000	44.1	1	1	0.023	0.023
4001-4100	37.0	2	2	0.054	0.054
4101-4200	29.0	0	0	0.000	0.000
4201-4300	20.4	1	1	0.049	0.049

TABLE B5

Replacement Rates for Generators on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	3	3	0.009	0.009
201-300	331.2	3	3	0.009	0.009
301-400	341.3	1	1	0.003	0.003
401-500	370.9	3	3	0.008	0.008
501-600	414.0	2	2	0.005	0.005
601-700	469.9	3	3	0.006	0.006
701-800	512.5	4	4	0.008	0.008
801-900	546.2	2	2	0.004	0.004
901-1000	567.0	4	4	0.007	0.007
1001-1100	579.6	3	3	0.005	0.005
1101-1200	593.0	1	1	0.002	0.002
1201-1300	598.4	2	2	0.003	0.003
1301-1400	603.8	3	3	0.005	0.005
1401-1500	607.7	6	6	0.010	0.010
1501-1600	607.0	4	4	0.007	0.007
1601-1700	607.4	5	5	0.008	0.008
1701-1800	602.6	14	14	0.023	0.023
1801-1900	596.3	6	6	0.010	0.010
1901-2000	581.1	4	4	0.007	0.007
2001-2100	562.6	5	5	0.009	0.009
2101-2200	544.1	4	4	0.007	0.007
2201-2300	513.5	6	6	0.012	0.012
2301-2400	460.9	7	7	0.015	0.015
2401-2500	409.0	5	5	0.012	0.012
2501-2600	353.1	3	3	0.008	0.008
2601-2700	312.4	5	5	0.016	0.016
2701-2800	273.7	2	2	0.007	0.007
2801-2900	240.4	2	2	0.008	0.008
2901-3000	215.8	1	1	0.005	0.005
3001-3100	189.1	3	3	0.016	0.016
3101-3200	162.4	2	2	0.012	0.012
3201-3300	134.5	1	1	0.007	0.007
3301-3400	109.3	1	1	0.009	0.009

TABLE B6

Replacement Rates for Final Drive Hubs on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	0	0	0.000	0.000
301-400	341.3	0	0	0.000	0.000
401-500	370.9	0	0	0.000	0.000
501-600	414.0	1	2	0.002	0.005
601-700	469.9	0	0	0.000	0.000
701-800	512.5	1	1	0.002	0.002
801-900	546.2	0	0	0.000	0.000
901-1000	567.0	1	2	0.002	0.004
1001-1100	579.6	0	0	0.000	0.000
1101-1200	593.0	0	0	0.000	0.000
1201-1300	598.4	0	0	0.000	0.000
1301-1400	603.8	0	0	0.000	0.000
1401-1500	607.7	1	1	0.002	0.002
1501-1600	607.0	0	0	0.000	0.000
1601-1700	607.4	2	2	0.003	0.003
1701-1800	602.6	5	5	0.008	0.008
1801-1900	596.3	4	9	0.007	0.015
1901-2000	581.1	5	8	0.009	0.014
2001-2100	562.6	4	8	0.007	0.014
2101-2200	544.1	4	7	0.007	0.013
2201-2300	513.5	10	14	0.019	0.027
2301-2400	460.9	11	19	0.024	0.041
2401-2500	409.0	6	11	0.015	0.027
2501-2600	353.1	2	4	0.006	0.011
2601-2700	312.4	4	6	0.013	0.019
2701-2800	273.7	8	14	0.029	0.051
2801-2900	240.4	6	8	0.025	0.033
2901-3000	215.8	3	3	0.014	0.014
3001-3100	189.1	3	3	0.016	0.016
3101-3200	162.4	1	2	0.006	0.012
3201-3300	134.5	1	1	0.007	0.007

TABLE B7

Replacement Rates for Link Assemblies on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	329.0	1	1	0.003	0.003
101-200	329.0	0	0	0.000	0.000
201-300	331.2	0	0	0.000	0.000
301-400	341.3	0	0	0.000	0.000
401-500	370.9	0	0	0.000	0.000
501-600	414.0	4	4	0.010	0.010
601-700	469.9	3	3	0.006	0.006
701-800	512.5	0	0	0.000	0.000
801-900	546.2	0	0	0.000	0.000
901-1000	567.0	1	1	0.002	0.002
1001-1100	579.6	1	1	0.002	0.002
1101-1200	593.0	0	0	0.000	0.000
1201-1300	598.4	0	0	0.000	0.000
1301-1400	603.8	2	2	0.003	0.003
1401-1500	607.7	1	1	0.002	0.002
1501-1600	607.0	1	1	0.002	0.002
1601-1700	607.4	1	1	0.002	0.002
1701-1800	602.6	2	2	0.003	0.003
1801-1900	596.3	2	2	0.003	0.003
1901-2000	581.1	4	5	0.007	0.009
2001-2100	562.6	3	3	0.005	0.005
2101-2200	544.1	3	3	0.006	0.006
2201-2300	513.5	3	4	0.006	0.008
2301-2400	460.9	4	5	0.009	0.011
2401-2500	409.0	3	3	0.007	0.007
2501-2600	353.1	2	3	0.006	0.008
2601-2700	312.4	2	3	0.006	0.010
2701-2800	273.7	1	1	0.004	0.004
2801-2900	240.4	0	0	0.000	0.000
2901-3000	215.8	2	2	0.009	0.009
3001-3100	189.1	1	1	0.005	0.005
3101-3200	162.4	1	1	0.006	0.006

TABLE B8

Replacement Rates for Fuel Injector Nozzles on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	329.0	3	5	0.009	0.015
101-200	329.0	5	5	0.015	0.015
201-300	331.2	2	2	0.006	0.006
301-400	341.3	1	1	0.003	0.003
401-500	370.9	1	1	0.003	0.003
501-600	414.0	4	10	0.010	0.024
601-700	469.9	3	3	0.006	0.006
701-800	512.5	3	4	0.006	0.008
801-900	546.2	1	2	0.002	0.004
901-1000	567.0	1	1	0.002	0.002
1001-1100	579.6	2	2	0.003	0.003
1101-1200	593.0	3	5	0.005	0.008
1201-1300	598.4	3	3	0.005	0.005
1301-1400	603.8	5	10	0.008	0.017
1401-1500	607.7	3	9	0.005	0.015
1501-1600	607.0	5	8	0.008	0.013
1601-1700	607.4	6	15	0.010	0.025
1701-1800	602.6	9	19	0.015	0.032
1801-1900	596.3	5	21	0.008	0.035
1901-2000	581.1	4	15	0.007	0.026
2001-2100	562.6	5	23	0.009	0.041
2101-2200	544.1	8	33	0.015	0.061
2201-2300	513.5	4	19	0.008	0.037
2301-2400	460.9	4	18	0.009	0.039
2401-2500	409.0	2	13	0.005	0.032
2501-2600	353.1	3	5	0.008	0.014
2601-2700	312.4	3	17	0.010	0.054
2701-2800	273.7	2	13	0.007	0.047

TABLE B9

Replacement Rates for Fuel Injection Pumps on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	1	1	0.003	0.003
201-300	331.2	0	0	0.000	0.000
301-400	341.3	0	0	0.000	0.000
401-500	370.9	1	1	0.003	0.003
501-600	414.0	2	2	0.005	0.005
601-700	469.9	2	2	0.004	0.004
701-800	512.5	0	0	0.000	0.000
801-900	546.2	3	3	0.005	0.005
901-1000	567.0	2	2	0.004	0.004
1001-1100	579.6	2	2	0.003	0.003
1101-1200	593.0	1	1	0.002	0.002
1201-1300	598.4	3	3	0.005	0.005
1301-1400	603.8	4	4	0.007	0.007
1401-1500	607.7	4	4	0.007	0.007
1501-1600	607.0	11	11	0.018	0.018
1601-1700	607.4	10	10	0.016	0.016
1701-1800	602.6	7	7	0.012	0.012
1801-1900	596.3	5	5	0.008	0.008
1901-2000	581.1	4	4	0.007	0.007
2001-2100	562.6	3	3	0.005	0.005
2101-2200	544.1	13	13	0.024	0.024
2201-2300	513.5	3	3	0.006	0.006
2301-2400	460.9	3	3	0.007	0.007
2401-2500	409.0	2	2	0.005	0.005
2501-2600	353.1	3	3	0.008	0.008
2601-2700	312.4	2	2	0.006	0.006
2701-2800	273.7	0	0	0.000	0.000
2801-2900	240.4	1	1	0.004	0.004
2901-3000	215.8	6	6	0.028	0.028
3001-3100	189.1	2	2	0.011	0.011
3101-3200	162.4	0	0	0.000	0.000
3201-3300	134.5	1	1	0.007	0.007
3301-3400	109.3	3	3	0.027	0.027
3401-3500	97.6	2	2	0.020	0.020
3501-3600	86.5	0	0	0.000	0.000
3601-3700	75.2	2	2	0.027	0.027
3701-3800	61.5	1	1	0.016	0.016

TABLE B10

Replacement Rates on Starter Relays on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-100	329.0	5	5	0.015	0.015
101-200	329.0	13	13	0.040	0.040
201-300	331.2	4	4	0.012	0.012
301-400	341.3	11	11	0.032	0.032
401-500	370.9	6	6	0.016	0.016
501-600	414.0	22	22	0.053	0.053
601-700	469.9	1	1	0.002	0.002
701-800	512.5	6	6	0.012	0.012
801-900	546.2	0	0	0.000	0.000
901-1000	567.0	0	0	0.000	0.000
1001-1100	579.6	2	2	0.003	0.003
1101-1200	593.0	6	6	0.010	0.010
1201-1300	598.4	4	4	0.007	0.007
1301-1400	603.8	9	9	0.015	0.015
1401-1500	607.7	12	12	0.020	0.020
1501-1600	607.0	11	11	0.018	0.018
1601-1700	607.4	12	12	0.020	0.020
1701-1800	602.6	4	4	0.007	0.007
1801-1900	596.3	6	6	0.010	0.010
1901-2000	581.1	8	8	0.014	0.014
2001-2100	562.6	7	7	0.012	0.012
2101-2200	544.1	13	13	0.024	0.024
2201-2300	513.5	3	3	0.006	0.006
2301-2400	460.9	5	5	0.011	0.011
2401-2500	409.0	2	2	0.005	0.005
2501-2600	353.1	1	1	0.003	0.003
2601-2700	312.4	0	0	0.000	0.000
2701-2800	273.7	0	0	0.000	0.000
2801-2900	240.4	1	1	0.004	0.004
2901-3000	215.8	2	2	0.009	0.009
3001-3100	189.1	1	1	0.005	0.005

TABLE 311

Replacement Rates for Shock Absorbers on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	0	0	0.000	0.000
301-400	341.3	0	0	0.000	0.000
401-500	370.9	0	0	0.000	0.000
501-600	414.0	0	0	0.000	0.000
601-700	469.9	0	0	0.000	0.000
701-800	512.5	0	0	0.000	0.000
801-900	546.2	0	0	0.000	0.000
901-1000	567.0	1	1	0.002	0.002
1001-1100	579.6	1	1	0.002	0.002
1101-1200	593.0	1	1	0.002	0.002
1201-1300	598.4	0	0	0.000	0.000
1301-1400	603.8	1	2	0.002	0.003
1401-1500	607.7	0	0	0.000	0.000
1501-1600	607.0	1	1	0.002	0.002
1601-1700	607.4	1	1	0.002	0.002
1701-1800	602.6	0	0	0.000	0.000
1801-1900	596.3	2	4	0.003	0.007
1901-2000	581.1	2	2	0.003	0.003
2001-2100	562.6	1	1	0.002	0.002
2101-2200	544.1	4	8	0.007	0.015
2201-2300	513.5	2	5	0.004	0.010
2301-2400	460.9	4	8	0.009	0.017
2401-2500	409.0	2	4	0.005	0.010
2501-2600	353.1	7	17	0.020	0.048
2601-2700	312.4	1	9	0.003	0.029
2701-2800	273.7	5	8	0.018	0.029
2801-2900	240.4	4	14	0.017	0.058
2901-3000	215.8	5	10	0.023	0.046
3001-3100	189.1	4	7	0.021	0.037
3101-3200	162.4	0	0	0.000	0.000
3201-3300	134.5	1	1	0.007	0.007
3301-3400	109.3	1	1	0.009	0.009
3401-3500	97.6	0	0	0.000	0.000
3501-3600	86.5	1	1	0.012	0.012
3601-3700	75.2	2	6	0.027	0.080

TABLE B12

Replacement Rates for Track Shoes on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	3	5	0.009	0.015
301-400	341.3	2	49	0.006	0.144
401-500	370.9	3	36	0.008	0.097
501-600	414.0	6	61	0.014	0.147
601-700	469.9	5	60	0.011	0.128
701-800	512.5	3	175	0.006	0.341
801-900	546.2	1	162	0.002	0.297
901-1000	567.0	3	323	0.005	0.570
1001-1100	579.6	5	468	0.009	0.807
1101-1200	593.0	4	167	0.007	0.282
1201-1300	598.4	5	21	0.008	0.035
1301-1400	603.8	5	333	0.008	0.552
1401-1500	607.7	10	1215	0.016	1.999
1501-1600	607.0	9	669	0.015	1.102
1601-1700	607.4	8	660	0.013	1.087
1701-1800	602.6	19	2436	0.032	4.042
1801-1900	596.3	23	2829	0.039	4.744
1901-2000	581.1	45	5439	0.077	9.360
2001-2100	562.6	52	7388	0.092	13.132
2101-2200	544.1	66	8972	0.121	16.490
2201-2300	513.5	60	9076	0.117	17.675
2301-2400	460.9	57	8378	0.124	18.177
2401-2500	409.0	52	7782	0.127	19.027
2501-2600	353.1	35	5416	0.099	15.338
2601-2700	312.4	24	3483	0.077	11.149
2701-2800	273.7	21	3185	0.077	11.637
2801-2900	240.4	23	3413	0.096	14.197
2901-3000	215.8	17	2501	0.079	11.589
3001-3100	189.1	16	2187	0.085	11.565
3101-3200	162.4	8	1294	0.049	7.968
3201-3300	134.5	6	752	0.045	5.591
3301-3400	109.3	7	972	0.064	8.893
3401-3500	97.6	4	239	0.041	2.449
3501-3600	86.5	5	658	0.058	7.607
3601-3700	75.2	3	482	0.040	6.410
3701-3800	61.5	3	480	0.049	7.805
3801-3900	51.3	9	975	0.175	19.006
3901-4000	44.1	3	482	0.068	10.930

TABLE B13

Replacement Rates for Sprockets on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	1	1	0.003	0.003
301-400	341.3	0	0	0.000	0.000
401-500	370.9	0	0	0.000	0.000
501-600	414.0	1	1	0.002	0.002
601-700	469.9	0	0	0.000	0.000
701-800	512.5	0	0	0.000	0.000
801-900	546.2	0	0	0.000	0.000
901-1000	567.0	3	10	0.005	0.018
1001-1100	579.6	0	0	0.000	0.000
1101-1200	593.0	1	4	0.002	0.007
1201-1300	598.4	1	4	0.002	0.007
1301-1400	603.8	4	12	0.007	0.020
1401-1500	607.7	9	32	0.015	0.053
1501-1600	607.0	10	26	0.016	0.043
1601-1700	607.4	8	25	0.013	0.041
1701-1800	602.6	13	40	0.022	0.066
1801-1900	596.3	9	26	0.015	0.044
1901-2000	581.1	21	71	0.036	0.122
2001-2100	562.6	22	79	0.039	0.140
2101-2200	544.1	19	68	0.035	0.125
2201-2300	513.5	19	76	0.037	0.148
2301-2400	460.9	28	106	0.061	0.230
2401-2500	409.0	23	92	0.056	0.225
2501-2600	353.1	16	59	0.045	0.167
2601-2700	312.4	14	53	0.045	0.170
2701-2800	273.7	22	88	0.080	0.322
2801-2900	240.4	19	70	0.079	0.291
2901-3000	215.8	15	49	0.070	0.227
3001-3100	189.1	3	12	0.016	0.635
3101-3200	162.4	6	22	0.037	0.135
3201-3300	134.5	3	8	0.022	0.059
3301-3400	109.3	1	2	0.009	0.018

TABLE B14

Replacement Rates for Starters on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	9	9	0.027	0.027
101-200	329.0	8	8	0.024	0.024
201-300	331.2	9	9	0.027	0.027
301-400	341.3	10	10	0.029	0.029
401-500	370.9	11	11	0.030	0.030
501-600	414.0	7	7	0.017	0.017
601-700	469.9	8	8	0.017	0.017
701-800	512.5	10	10	0.020	0.020
801-900	546.2	11	11	0.020	0.020
901-1000	567.0	13	13	0.023	0.023
1001-1100	579.6	12	12	0.021	0.021
1101-1200	593.0	11	11	0.019	0.019
1201-1300	598.4	9	9	0.015	0.015
1301-1400	603.8	10	10	0.017	0.017
1401-1500	607.7	18	18	0.030	0.030
1501-1600	607.0	24	24	0.040	0.040
1601-1700	607.4	15	15	0.025	0.025
1701-1800	602.6	19	19	0.032	0.032
1801-1900	596.3	20	20	0.034	0.034
1901-2000	581.1	9	9	0.015	0.015
2001-2100	562.6	15	15	0.027	0.027
2101-2200	544.1	11	11	0.020	0.020
2201-2300	513.5	8	8	0.016	0.016
2301-2400	460.9	10	10	0.022	0.022
2401-2500	409.0	12	12	0.029	0.029
2501-2600	353.1	2	2	0.006	0.006
2601-2700	312.4	6	6	0.019	0.019
2701-2800	273.7	5	5	0.018	0.018
2801-2900	240.4	6	6	0.025	0.025
2901-3000	215.8	4	4	0.019	0.019
3001-3100	189.1	3	3	0.016	0.016
3101-3200	162.4	4	4	0.025	0.025
3201-3300	134.5	0	0	0.000	0.000
3301-3400	109.3	1	1	0.009	0.009
3401-3500	97.6	1	1	0.010	0.010
3501-3600	86.5	3	3	0.035	0.035
3601-3700	75.2	1	1	0.013	0.013
3701-3800	61.5	0	0	0.000	0.000
3801-3900	51.3	1	1	0.019	0.019

TABLE B15

Replacement Rates for Transmissions on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	639.0	2	2	0.003	0.003
101-200	639.0	2	2	0.003	0.003
201-300	638.0	3	3	0.005	0.005
301-400	637.0	0	0	0.000	0.000
401-500	634.6	1	1	0.002	0.002
501-600	634.0	4	4	0.006	0.006
601-700	632.9	1	1	0.002	0.002
701-800	631.0	2	2	0.003	0.003
801-900	630.0	4	4	0.006	0.006
901-1000	630.0	3	3	0.005	0.005
1001-1100	628.8	3	3	0.005	0.005
1101-1200	628.0	1	1	0.002	0.002
1201-1300	625.9	0	0	0.000	0.000
1301-1400	621.7	2	2	0.003	0.003
1401-1500	619.2	5	5	0.008	0.008
1501-1600	614.6	3	3	0.005	0.005
1601-1700	608.7	3	3	0.005	0.005
1701-1800	602.6	2	2	0.003	0.003
1801-1900	596.3	2	2	0.003	0.003
1901-2000	581.1	5	5	0.009	0.009
2001-2100	562.6	4	4	0.007	0.007
2101-2200	544.1	2	2	0.004	0.004
2201-2300	513.5	7	7	0.014	0.014
2301-2400	460.9	3	3	0.007	0.007
2401-2500	409.0	4	4	0.010	0.010
2501-2600	353.1	3	3	0.008	0.008
2601-2700	312.4	6	6	0.019	0.019
2701-2800	273.7	3	3	0.011	0.011
2801-2900	240.4	4	4	0.017	0.017
2901-3000	215.8	1	1	0.005	0.005
3001-3100	189.1	4	4	0.021	0.021

TABLE B16

Replacement Rates for Traverse Gear Boxes on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	329.0	2	2	0.006	0.006
101-200	329.0	2	2	0.006	0.006
201-300	331.2	3	3	0.009	0.009
301-400	341.3	0	0	0.000	0.000
401-500	370.9	1	1	0.003	0.003
501-600	414.0	2	2	0.005	0.005
601-700	469.9	0	0	0.000	0.000
701-800	512.5	2	2	0.004	0.004
801-900	546.2	2	2	0.004	0.004
901-1000	567.0	2	2	0.004	0.004
1001-1100	579.6	3	3	0.005	0.005
1101-1200	593.0	1	1	0.002	0.002
1201-1300	598.4	0	0	0.000	0.000
1301-1400	603.8	2	2	0.003	0.003
1401-1500	607.7	5	5	0.008	0.008
1501-1600	607.0	4	4	0.007	0.007
1601-1700	607.4	3	3	0.005	0.005
1701-1800	602.6	2	2	0.003	0.003
1801-1900	596.3	2	2	0.003	0.003
1901-2000	581.1	4	4	0.007	0.007
2001-2100	562.6	4	4	0.007	0.007
2101-2200	544.1	2	2	0.004	0.004
2201-2300	513.5	2	2	0.004	0.004
2301-2400	460.9	3	3	0.007	0.007
2401-2500	409.0	4	4	0.010	0.010
2501-2600	353.1	3	3	0.008	0.008
2601-2700	312.4	5	5	0.016	0.016
2701-2800	273.7	2	2	0.007	0.007
2801-2900	240.4	3	3	0.012	0.012
2901-3000	215.8	1	1	0.005	0.005
3001-3100	189.1	3	3	0.016	0.016

TABLE B17

Replacement Rates for Superchargers on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331.2	3	3	0.009	0.009
301-400	341.3	0	0	0.000	0.000
401-500	370.9	0	0	0.000	0.000
501-600	414.0	0	0	0.000	0.000
601-700	469.9	1	1	0.002	0.002
701-800	512.5	0	0	0.000	0.000
801-900	546.2	1	1	0.002	0.002
901-1000	567.0	1	1	0.002	0.002
1001-1100	579.6	1	1	0.002	0.002
1101-1200	593.0	1	1	0.002	0.002
1201-1300	598.4	0	0	0.000	0.000
1301-1400	603.8	0	0	0.000	0.000
1401-1500	607.7	3	3	0.005	0.005
1501-1600	607.0	1	1	0.002	0.002
1601-1700	607.4	1	1	0.002	0.002
1701-1800	602.6	1	1	0.002	0.002
1801-1900	596.3	0	0	0.000	0.000
1901-2000	581.1	1	1	0.002	0.002
2001-2100	562.6	0	0	0.000	0.000
2101-2200	544.1	1	1	0.002	0.002
2201-2300	513.5	0	0	0.000	0.000
2301-2400	460.9	2	2	0.004	0.004
2401-2500	409.0	0	0	0.000	0.000
2501-2600	353.1	0	0	0.000	0.000
2601-2700	312.4	2	2	0.006	0.006

TABLE B18

Replacement Rates for Road and Idler Wheels on M60 Tanks in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	329.0	0	0	0.000	0.000
101-200	329.0	0	0	0.000	0.000
201-300	331-2	0	0	0.000	0.000
301-400	341.3	0	0	0.000	0.000
401-500	370.9	4	6	0.011	0.016
501-600	414.0	0	0	0.000	0.000
601-700	469.9	4	4	0.009	0.009
701-800	512.5	3	5	0.006	0.010
801-900	546.2	4	6	0.007	0.011
901-1000	567.0	2	14	0.004	0.025
1001-1100	579.6	3	6	0.005	0.010
1101-1200	593.0	4	9	0.007	0.015
1201-1300	598.4	4	17	0.007	0.028
1301-1400	603.8	8	22	0.013	0.036
1401-1500	607.7	6	9	0.010	0.015
1501-1600	607.0	5	8	0.008	0.013
1601-1700	607.4	4	14	0.007	0.023
1701-1800	602.6	8	15	0.013	0.025
1801-1900	596.3	14	38	0.023	0.064
1901-2000	581.1	17	44	0.029	0.076
2001-2100	562.6	20	52	0.036	0.092
2101-2200	544.1	12	36	0.022	0.066
2201-2300	513.5	16	42	0.031	0.082
2301-2400	460.9	12	35	0.026	0.076
2401-2500	409.0	17	52	0.042	0.127
2501-2600	353.1	7	20	0.020	0.057
2601-2700	312.4	16	61	0.051	0.195
2701-2800	273.7	16	70	0.058	0.256
2801-2900	240.4	16	45	0.067	0.187
2901-3000	215.8	13	51	0.060	0.236
3001-3100	189.1	12	43	0.063	0.227
3101-3200	162.4	4	6	0.025	0.037
3201-3300	134.5	4	16	0.030	0.119
3301-3400	109.3	4	8	0.037	0.073
3401-3500	97.6	1	1	0.010	0.010
3501-3600	86.5	3	9	0.035	0.104
3601-3700	75.2	4	15	0.053	0.199
3701-3800	61.5	4	6	0.065	0.098
3801-3900	51.3	3	4	0.058	0.078
3901-4000	44.1	3	6	0.068	0.136
4001-4100	37.0	3	12	0.081	0.324
4101-4200	29.0	0	0	0.000	0.000
4201-4300	20.4	2	3	0.098	0.147
4301-4400	15.4	4	10	0.260	0.649
4401-4500	10.6	2	2	0.189	0.189

IN USAREUR, BASED ON MONTHS IN SERVICE

TABLE B19

Replacement Rates for Road and Idler Wheel Arms on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	0	0	0.000	0.000
2-3	435.2	0	0	0.000	0.000
3-4	529.6	3	3	0.006	0.006
4-5	539.2	1	1	0.002	0.002
5-6	545.2	2	2	0.004	0.004
6-7	562.7	1	1	0.002	0.002
7-8	598.7	2	3	0.003	0.005
8-9	618.2	0	0	0.000	0.000
9-10	616.6	4	4	0.006	0.006
10-11	616.2	1	1	0.002	0.002
11-12	614.5	4	4	0.007	0.007
12-13	613.0	3	3	0.005	0.005
13-14	612.1	2	2	0.003	0.003
14-15	605.1	3	4	0.005	0.007
15-16	583.2	3	3	0.005	0.005
16-17	569.6	1	1	0.002	0.002
17-18	548.9	7	18	0.013	0.033
18-19	534.8	9	11	0.017	0.021
19-20	533.7	3	3	0.006	0.006
20-21	498.1	3	3	0.006	0.006
21-22	326.8	4	4	0.012	0.012
22-23	249.6	4	4	0.016	0.016
23-24	151.7	1	5	0.007	0.033
24-25	50.3	3	3	0.060	0.060

TABLE B20

Replacement Rates for Batteries on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	2	2	0.006	0.006
1-2	335.1	4	10	0.012	0.030
2-3	435.2	2	2	0.005	0.005
3-4	529.6	3	8	0.006	0.015
4-5	539.2	0	0	0.000	0.000
5-6	545.2	3	8	0.006	0.015
6-7	562.7	2	2	0.004	0.004
7-8	598.7	2	3	0.003	0.005
8-9	618.2	2	3	0.003	0.005
9-10	616.6	2	3	0.003	0.005
10-11	616.2	4	8	0.006	0.013
11-12	614.5	3	5	0.005	0.008
12-13	613.0	3	3	0.005	0.005
13-14	612.1	3	8	0.005	0.013
14-15	605.1	3	12	0.005	0.020
15-16	583.2	3	8	0.005	0.014
16-17	569.6	1	2	0.002	0.004
17-18	548.9	3	3	0.005	0.005
18-19	534.8	2	8	0.004	0.015
19-20	533.7	4	15	0.007	0.028
20-21	498.1	7	15	0.014	0.030
21-22	326.8	3	3	0.009	0.009
22-23	249.6	5	20	0.020	0.080
23-24	151.7	1	6	0.007	0.040
24-25	50.3	0	0	0.000	0.000
25-26	38.0	2	10	0.053	0.263

TABLE B21

Replacement Rates for Engines on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-1	639.0	4	4	0.006	0.006
1-2	636.9	8	8	0.013	0.013
2-3	635.0	8	8	0.013	0.013
3-4	633.9	3	3	0.005	0.005
4-5	633.0	7	7	0.011	0.011
5-6	629.9	7	7	0.011	0.011
6-7	629.0	3	3	0.005	0.005
7-8	628.4	3	3	0.005	0.005
8-9	625.0	3	3	0.005	0.005
9-10	622.0	6	6	0.010	0.010
10-11	621.0	8	8	0.013	0.013
11-12	618.0	23	23	0.037	0.037
12-13	615.0	14	14	0.023	0.023
13-14	613.4	24	24	0.039	0.039
14-15	603.2	31	31	0.051	0.051
15-16	582.2	22	22	0.038	0.038
16-17	569.6	19	19	0.033	0.033
17-18	548.9	27	27	0.049	0.049
18-19	534.8	19	19	0.036	0.036
19-20	533.7	10	10	0.019	0.019
20-21	498.1	15	15	0.030	0.030
21-22	326.8	8	8	0.024	0.024
22-23	249.6	5	5	0.020	0.020
23-24	151.7	7	7	0.046	0.046
24-25	50.3	0	0	0.000	0.000
25-26	38.0	2	2	0.053	0.053
26-27	17.9	1	1	0.056	0.056

TABLE B22

Replacement Rates for Generators on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/n}$ replacement rate for: Maintenance actions	$R_{a/n}$ replacement rate for: Parts replaced
0-1	330.5	2	2	0.006	0.006
1-2	335.1	5	5	0.015	0.015
2-3	435.2	5	5	0.011	0.011
3-4	529.6	1	1	0.002	0.002
4-5	539.2	5	5	0.009	0.009
5-6	545.2	2	2	0.004	0.004
6-7	562.7	6	6	0.011	0.011
7-8	598.7	5	5	0.008	0.008
8-9	618.2	2	2	0.003	0.003
9-10	616.6	5	5	0.008	0.008
10-11	616.2	5	5	0.008	0.008
11-12	614.5	7	7	0.011	0.011
12-13	613.0	4	4	0.007	0.007
13-14	612.1	9	9	0.015	0.015
14-15	605.1	15	15	0.025	0.025
15-16	583.2	6	6	0.010	0.010
16-17	569.6	9	9	0.016	0.016
17-18	548.9	6	6	0.011	0.011
18-19	534.8	10	10	0.019	0.019
19-20	533.7	6	6	0.011	0.011
20-21	498.1	3	3	0.006	0.006
21-22	326.8	2	2	0.006	0.006
22-23	249.6	1	1	0.004	0.004
23-24	151.7	1	1	0.007	0.007

TABLE B23

Replacement Rates for Final Drive Hubs on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	0	0	0.000	0.000
2-3	435.2	0	0	0.000	0.000
3-4	529.6	0	0	0.000	0.000
4-5	539.2	0	0	0.000	0.000
5-6	545.2	0	0	0.000	0.000
6-7	562.7	1	1	0.002	0.002
7-8	598.7	0	0	0.000	0.000
8-9	610.2	0	0	0.000	0.000
9-10	616.6	0	0	0.000	0.000
10-11	616.2	3	3	0.005	0.005
11-12	614.5	5	7	0.008	0.011
12-13	613.0	3	7	0.005	0.011
13-14	612.1	3	3	0.005	0.005
14-15	605.1	2	2	0.003	0.003
15-16	583.2	5	8	0.009	0.014
16-17	569.6	7	10	0.012	0.018
17-18	548.9	1	2	0.002	0.004
18-19	534.8	5	5	0.009	0.009
19-20	533.7	20	31	0.037	0.058
20-21	498.1	17	32	0.034	0.064
21-22	326.8	9	14	0.028	0.043
22-23	249.6	2	3	0.008	0.012
23-24	151.7	0	0	0.000	0.000
24-25	50.3	0	0	0.000	0.000
25-26	38.0	0	0	0.000	0.000
26-27	17.9	1	2	0.056	0.112

TABLE B24

Replacement Rates for Link Assemblies on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	2	2	0.006	0.006
2-3	435.2	0	0	0.000	0.000
3-4	529.6	3	3	0.006	0.006
4-5	539.2	4	4	0.007	0.007
5-6	545.2	0	0	0.000	0.000
6-7	562.7	3	3	0.005	0.005
7-8	598.7	1	1	0.002	0.002
8-9	618.2	1	1	0.002	0.002
9-10	616.6	1	1	0.002	0.002
10-11	616.2	5	6	0.008	0.010
11-12	614.5	4	4	0.007	0.007
12-13	613.0	5	5	0.008	0.008
13-14	612.1	2	2	0.003	0.003
14-15	605.1	2	2	0.003	0.003
15-16	583.2	3	3	0.005	0.005
16-17	569.6	2	3	0.004	0.005
17-18	548.9	3	4	0.005	0.007
18-19	534.8	4	4	0.007	0.007
19-20	533.7	2	4	0.004	0.007
20-21	498.1	3	3	0.006	0.006
21-22	326.8	1	1	0.003	0.003
22-23	249.6	5	7	0.020	0.028
23-24	151.7	1	1	0.007	0.007
24-25	50.3	1	1	0.020	0.020

TABLE B25

Replacement Rates for Fuel Injector Nozzles on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	4	6	0.012	0.018
1-2	335.1	5	5	0.015	0.015
2-3	435.2	4	10	0.009	0.023
3-4	529.6	4	15	0.008	0.028
4-5	539.2	4	5	0.007	0.009
5-6	545.2	2	2	0.004	0.004
6-7	562.7	1	2	0.002	0.004
7-8	598.7	5	7	0.008	0.012
8-9	618.2	6	11	0.010	0.018
9-10	616.6	2	2	0.003	0.003
10-11	616.2	4	6	0.006	0.010
11-12	614.5	8	31	0.013	0.050
12-13	613.0	14	27	0.023	0.044
13-14	612.1	10	52	0.016	0.085
14-15	605.1	5	21	0.008	0.035
15-16	583.2	5	11	0.009	0.019
16-17	569.6	3	16	0.005	0.028
17-18	548.9	5	29	0.009	0.053
18-19	534.8	5	14	0.009	0.026
19-20	533.7	0	0	0.000	0.000
20-21	498.1	3	10	0.006	0.020
21-22	326.8	1	1	0.003	0.003
22-23	249.6	1	1	0.004	0.004
23-24	151.7	1	12	0.007	0.079

TABLE B26

Replacement Rates on Fuel Injection Pumps on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	2	2	0.006	0.006
2-3	435.2	0	0	0.000	0.000
3-4	529.6	2	2	0.004	0.004
4-5	539.2	4	4	0.007	0.007
5-6	545.2	3	3	0.006	0.006
6-7	562.7	4	4	0.007	0.007
7-8	598.7	8	8	0.013	0.013
8-9	618.2	6	6	0.010	0.010
9-10	616.6	5	5	0.008	0.008
10-11	616.2	3	3	0.005	0.005
11-12	614.5	5	5	0.008	0.008
12-13	613.0	6	6	0.010	0.010
13-14	612.1	9	9	0.015	0.015
14-15	605.1	6	6	0.010	0.010
15-16	583.2	5	5	0.009	0.009
16-17	569.6	4	4	0.007	0.007
17-18	548.9	5	5	0.009	0.009
18-19	534.8	7	7	0.013	0.013
19-20	533.7	9	9	0.017	0.017
20-21	498.1	11	11	0.022	0.022
21-22	326.8	1	1	0.003	0.003
22-23	249.6	3	3	0.012	0.012
23-24	151.7	1	1	0.007	0.007
24-25	50.3	1	1	0.020	0.020

TABLE B27

Replacement Rates for Starter Relays on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	8	8	0.024	0.024
1-2	335.1	18	18	0.054	0.054
2-3	435.2	12	12	0.028	0.028
3-4	529.6	20	20	0.038	0.038
4-5	539.2	6	6	0.011	0.011
5-6	545.2	2	2	0.004	0.004
6-7	562.7	2	2	0.004	0.004
7-8	598.7	0	0	0.000	0.000
8-9	618.2	0	0	0.000	0.000
9-10	616.6	9	9	0.015	0.015
10-11	616.2	20	20	0.032	0.032
11-12	614.5	20	20	0.033	0.033
12-13	613.0	23	23	0.038	0.038
13-14	612.1	21	21	0.034	0.034
14-15	605.1	3	3	0.005	0.005
15-16	583.2	2	2	0.003	0.003
16-17	569.6	1	1	0.002	0.002
17-18	548.9	1	1	0.002	0.002
18-19	534.8	3	3	0.006	0.006
19-20	533.7	2	2	0.004	0.004
20-21	498.1	1	1	0.002	0.002
21-22	326.8	1	1	0.003	0.003
22-23	249.6	1	1	0.004	0.004
23-24	151.7	0	0	0.000	0.000
24-25	50.3	0	0	0.000	0.000
25-26	38.0	1	1	0.026	0.026

TABLE B28

Replacement Rates for Shock Absorbers on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	0	0	0.000	0.000
2-3	435.2	0	0	0.000	0.000
3-4	529.6	0	0	0.000	0.000
4-5	539.2	0	0	0.000	0.000
5-6	545.2	2	2	0.004	0.004
6-7	562.7	0	0	0.000	0.000
7-8	598.7	0	0	0.000	0.000
8-9	618.2	1	1	0.002	0.002
9-10	616.6	0	0	0.000	0.000
10-11	616.2	1	1	0.002	0.002
11-12	614.5	4	10	0.007	0.016
12-13	613.0	1	1	0.002	0.002
13-14	612.1	5	10	0.008	0.016
14-15	605.1	2	10	0.003	0.017
15-16	583.2	1	2	0.002	0.003
16-17	569.6	3	11	0.005	0.019
17-18	548.9	5	12	0.009	0.022
18-19	534.8	6	7	0.011	0.013
19-20	533.7	6	10	0.011	0.019
20-21	498.1	7	15	0.014	0.030
21-22	326.8	4	11	0.012	0.034
22-23	249.6	5	12	0.020	0.048
23-24	151.7	2	3	0.013	0.020

TABLE B29

Replacement Rates for Track Shoes on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	3	41	0.009	0.122
2-3	435.2	12	133	0.028	0.306
3-4	529.6	5	166	0.009	0.313
4-5	539.2	4	338	0.007	0.627
5-6	545.2	6	179	0.011	0.328
6-7	562.7	3	182	0.005	0.323
7-8	598.7	5	469	0.008	0.783
8-9	618.2	15	1649	0.024	2.667
9-10	616.6	14	659	0.023	1.069
10-11	616.2	44	6074	0.071	9.857
11-12	614.5	40	4914	0.065	7.997
12-13	613.0	60	8596	0.098	14.023
13-14	612.1	38	4871	0.062	7.958
14-15	605.1	22	2305	0.036	3.809
15-16	583.2	30	3678	0.014	6.307
16-17	569.6	50	6511	0.088	11.431
17-18	548.9	62	9690	0.113	17.653
18-19	534.8	30	4454	0.056	8.328
19-20	533.7	31	4688	0.058	8.784
20-21	498.1	41	5985	0.082	12.016
21-22	326.8	77	12112	0.236	37.062
22-23	249.6	23	3722	0.092	14.912
23-24	151.7	12	1859	0.079	12.254
24-25	50.3	1	160	0.020	3.181

TABLE B30

Replacement Rates for Sprockets on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	1	1	0.003	0.003
2-3	435.2	1	1	0.002	0.002
3-4	529.6	0	0	0.000	0.000
4-5	539.2	0	0	0.000	0.000
5-6	545.2	1	4	0.002	0.007
6-7	562.7	2	4	0.004	0.007
7-8	598.7	1	2	0.002	0.003
8-9	618.2	1	4	0.002	0.006
9-10	616.6	3	5	0.005	0.008
10-11	616.2	4	8	0.006	0.013
11-12	614.5	18	63	0.029	0.103
12-13	613.0	14	41	0.023	0.067
13-14	612.1	27	101	0.044	0.165
14-15	605.1	22	67	0.036	0.111
15-16	583.2	27	100	0.046	0.171
16-17	569.6	61	242	0.107	0.425
17-18	548.9	21	76	0.038	0.138
18-19	534.8	.7	25	0.013	0.047
19-20	533.7	36	134	0.067	0.251
20-21	498.1	19	72	0.038	0.145
21-22	326.8	16	52	0.049	0.159
22-23	249.6	6	19	0.024	0.076
23-24	151.7	1	2	0.007	0.013

TABLE B31

Replacement Rates for Starters on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	15	15	0.045	0.045
1-2	335.1	15	15	0.045	0.045
2-3	435.2	17	17	0.039	0.039
3-4	529.6	16	16	0.030	0.030
4-5	539.2	25	25	0.046	0.046
5-6	545.2	11	11	0.020	0.020
6-7	562.7	17	17	0.030	0.030
7-8	598.7	15	15	0.025	0.025
8-9	618.2	17	17	0.027	0.027
9-10	616.6	13	13	0.021	0.021
10-11	616.2	16	16	0.026	0.026
11-12	614.5	14	14	0.023	0.023
12-13	613.0	25	25	0.041	0.041
13-14	612.1	28	28	0.046	0.046
14-15	605.1	13	13	0.021	0.021
15-16	583.2	21	21	0.036	0.036
16-17	569.6	8	8	0.014	0.014
17-18	548.9	8	8	0.015	0.015
18-19	534.8	5	5	0.009	0.009
19-20	533.7	14	14	0.026	0.026
20-21	498.1	5	5	0.010	0.010
21-22	326.8	7	7	0.021	0.021
22-23	249.6	5	5	0.020	0.020
23-24	151.7	4	4	0.026	0.026
24-25	50.3	1	1	0.020	0.020

TABLE B32

Replacement Rates for Transmissions on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	639.0	3	3	0.005	0.005
1-2	636.9	2	2	0.003	0.003
2-3	635.0	3	3	0.005	0.005
3-4	633.9	3	3	0.005	0.005
4-5	633.0	5	5	0.008	0.008
5-6	629.9	1	1	0.002	0.002
6-7	629.0	4	4	0.006	0.006
7-8	628.4	5	5	0.008	0.008
8-9	625.0	1	1	0.002	0.002
9-10	622.0	2	2	0.003	0.003
10-11	621.0	5	5	0.008	0.008
11-12	618.0	8	8	0.013	0.013
12-13	615.0	4	4	0.007	0.007
13-14	613.4	5	5	0.008	0.008
14-15	603.2	8	8	0.013	0.013
15-16	582.2	3	3	0.005	0.005
16-17	569.6	5	5	0.009	0.009
17-18	548.9	7	7	0.013	0.013
18-19	534.8	4	4	0.007	0.007
19-20	533.7	2	2	0.004	0.004
20-21	498.1	3	3	0.006	0.006
21-22	326.8	3	3	0.009	0.009
22-23	249.6	2	2	0.008	0.008
23-24	151.7	1	1	0.007	0.007

TABLE B33

Replacement Rates for Traverse Gear Boxes on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	330.5	3	3	0.009	0.009
1-2	335.1	2	2	0.006	0.006
2-3	435.2	3	3	0.007	0.007
3-4	529.6	2	2	0.004	0.004
4-5	539.2	3	3	0.005	0.005
5-6	545.2	1	1	0.002	0.002
6-7	562.7	3	3	0.005	0.005
7-8	598.7	5	5	0.008	0.008
8-9	618.2	1	1	0.002	0.002
9-10	616.6	2	2	0.003	0.003
10-11	616.2	5	5	0.008	0.008
11-12	614.5	7	7	0.011	0.011
12-13	613.0	4	4	0.007	0.007
13-14	612.1	5	5	0.008	0.008
14-15	605.1	7	7	0.012	0.012
15-16	583.2	3	3	0.005	0.005
16-17	569.6	4	4	0.007	0.007
17-18	548.9	5	5	0.009	0.009
18-19	534.8	4	4	0.007	0.007
19-20	533.7	2	2	0.004	0.004
20-21	498.1	2	2	0.004	0.004
21-22	326.8	1	1	0.003	0.003
22-23	249.6	2	2	0.008	0.008

TABLE B34

Replacement Rates for Superchargers on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	1	1	0.003	0.003
2-3	435.2	3	3	0.007	0.007
3-4	529.6	3	3	0.006	0.006
4-5	539.2	2	2	0.004	0.004
5-6	545.2	1	1	0.002	0.002
6-7	562.7	2	2	0.004	0.004
7-8	598.7	5	5	0.008	0.008
8-9	618.2	2	2	0.003	0.003
9-10	616.6	3	3	0.005	0.005
10-11	616.2	5	5	0.008	0.008
11-12	614.5	4	4	0.007	0.007
12-13	613.0	2	2	0.003	0.003
13-14	612.1	2	2	0.003	0.003
14-15	605.1	6	6	0.010	0.010
15-16	583.2	1	1	0.002	0.002
16-17	569.6	3	3	0.005	0.005
17-18	548.9	2	2	0.004	0.004
18-19	534.8	4	4	0.007	0.007
19-20	533.7	1	1	0.002	0.002
20-21	498.1	3	3	0.006	0.006
21-22	326.8	0	0	0.000	0.000
22-23	249.6	1	1	0.004	0.004

TABLE B35

Replacement Rates for Road and Idler Wheels on M60 Tanks in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	330.5	0	0	0.000	0.000
1-2	335.1	0	0	0.000	0.000
2-3	435.2	5	8	0.011	0.018
3-4	529.6	3	4	0.006	0.008
4-5	539.2	5	8	0.009	0.015
5-6	545.2	0	0	0.000	0.000
6-7	562.7	5	19	0.009	0.034
7-8	598.7	13	39	0.022	0.065
8-9	618.2	4	7	0.006	0.011
9-10	616.6	1	2	0.002	0.003
10-11	616.2	7	14	0.011	0.023
11-12	614.5	9	17	0.015	0.028
12-13	613.0	5	22	0.008	0.036
13-14	612.1	26	77	0.042	0.126
14-15	605.1	15	38	0.025	0.063
15-16	583.2	17	35	0.029	0.060
16-17	569.6	23	61	0.040	0.107
17-18	548.9	18	49	0.033	0.089
18-19	534.8	28	105	0.052	0.196
19-20	533.7	31	84	0.058	0.157
20-21	498.1	28	117	0.056	0.235
21-22	326.8	21	53	0.064	0.162
22-23	249.6	9	19	0.036	0.076
23-24	151.7	13	38	0.086	0.250
24-25	50.3	1	8	0.020	0.159

TABLE B36

Replacement Rates for Engines on M60 Tanks in 3d Armd Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	249.0	1	1	0.004	0.004
101-200	249.0	2	2	0.008	0.008
201-300	248.0	2	2	0.008	0.008
301-400	248.0	3	3	0.012	0.012
401-500	246.0	1	1	0.004	0.004
501-600	246.0	4	4	0.016	0.016
601-700	246.0	0	0	0.000	0.000
701-800	246.0	2	2	0.008	0.008
801-900	245.0	0	0	0.000	0.000
901-1000	245.0	0	0	0.000	0.000
1001-1100	245.0	0	0	0.000	0.000
1101-1200	245.0	0	0	0.000	0.000
1201-1300	244.9	3	3	0.012	0.012
1301-1400	244.0	2	2	0.008	0.008
1401-1500	244.0	0	0	0.000	0.000
1501-1600	244.0	6	6	0.025	0.025
1601-1700	243.3	0	0	0.000	0.000
1701-1800	242.6	2	2	0.008	0.008
1801-1900	242.0	6	6	0.025	0.025
1901-2000	239.9	1	1	0.004	0.004
2001-2100	237.8	5	5	0.021	0.021
2101-2200	236.5	5	5	0.021	0.021
2201-2300	233.9	6	6	0.026	0.026
2301-2400	230.0	14	14	0.061	0.061
2401-2500	225.1	6	6	0.027	0.027
2501-2600	215.3	7	7	0.033	0.033
2601-2700	203.1	9	9	0.044	0.044
2701-2800	194.5	11	11	0.057	0.057
2801-2900	188.4	7	7	0.037	0.037
2901-3000	177.0	3	3	0.017	0.017
3001-3100	164.8	3	3	0.018	0.018
3101-3200	144.7	3	3	0.021	0.021
3201-3300	124.5	3	3	0.024	0.024
3301-3400	107.0	3	3	0.028	0.028
3401-3500	96.6	4	4	0.041	0.041
3501-3600	85.5	1	1	0.012	0.012
3601-3700	75.2	2	2	0.027	0.027
3701-3800	61.5	2	2	0.033	0.033
3801-3900	51.3	1	1	0.019	0.019
3901-4000	44.1	1	1	0.023	0.023
4001-4100	37.0	2	2	0.054	0.054
4101-4200	29.0	0	0	0.000	0.000
4201-4300	20.4	1	1	0.049	0.049

TABLE B37

Replacement Rates for Track Shoes on M60 Tanks in 3d Armd Div

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	18.0	0	0	0.000	0.000
101-200	18.0	0	0	0.000	0.000
201-300	20.2	0	0	0.000	0.000
301-400	31.3	1	12	0.032	0.383
401-500	60.7	3	36	0.049	0.593
501-600	97.2	5	60	0.051	0.617
601-700	144.1	5	60	0.035	0.416
701-800	180.4	3	175	0.017	0.970
801-900	211.4	0	0	0.000	0.000
901-1000	222.2	2	322	0.009	1.449
1001-1100	223.0	3	325	0.013	1.457
1101-1200	223.6	0	0	0.000	0.000
1201-1300	224.6	2	14	0.009	0.062
1301-1400	229.9	2	324	0.009	1.409
1401-1500	234.5	5	808	0.021	3.446
1501-1600	238.0	7	666	0.029	2.798
1601-1700	242.0	3	329	0.012	1.360
1701-1800	242.6	10	1450	0.041	5.977
1801-1900	242.0	13	1941	0.054	8.021
1901-2000	239.9	27	3264	0.113	13.606
2001-2100	237.8	34	4943	0.143	20.786
2101-2200	236.5	34	5217	0.144	22.059
2201-2300	233.9	25	3922	0.107	16.768
2301-2400	230.0	23	3238	0.100	14.078
2401-2500	225.1	20	2771	0.089	12.310
2501-2600	215.3	20	2992	0.093	13.897
2601-2700	203.1	15	2031	0.074	10.000
2701-2800	194.5	8	1085	0.041	5.578
2801-2900	188.4	15	2119	0.080	11.247
2901-3000	177.0	13	1853	0.073	10.469
3001-3100	164.8	11	1377	0.067	8.356
3101-3200	144.7	6	970	0.041	6.704
3201-3300	124.5	5	590	0.040	4.739
3301-3400	107.0	7	972	0.065	9.084
3401-3500	96.6	4	239	0.041	2.472
3501-3600	85.5	5	658	0.058	7.696
3601-3700	75.2	3	482	0.040	6.410
3701-3800	61.5	3	480	0.049	7.805
3801-3900	51.3	9	975	0.175	19.006
3901-4000	44.1	3	482	0.068	10.930
4001-4100	37.0	4	484	0.108	13.081
4101-4200	29.0	3	321	0.103	11.070
4201-4300	20.4	1	162	0.049	7.941
4301-4400	15.4	1	160	0.065	10.390
4401-4500	10.6	0	0	0.000	0.000
4501-4600	9.1	2	166	0.220	18.242

TABLE B38

Replacement Rates for Sprockets on M60 Tanks in 3d Armd Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	18.0	0	0	0.000	0.000
101-200	18.0	0	0	0.000	0.000
201-300	20.2	0	0	0.000	0.000
301-400	31.3	0	0	0.000	0.000
401-500	60.7	0	0	0.000	0.000
501-600	97.2	1	1	0.010	0.010
601-700	144.1	0	0	0.000	0.000
701-800	180.4	0	0	0.000	0.000
801-900	211.4	0	0	0.000	0.000
901-1000	222.2	0	0	0.000	0.000
1001-1100	223.0	0	0	0.000	0.000
1101-1200	223.6	0	0	0.000	0.000
1201-1300	224.6	0	0	0.000	0.000
1301-1400	229.9	1	2	0.004	0.009
1401-1500	234.5	2	6	0.009	0.026
1501-1600	238.0	2	5	0.008	0.021
1601-1700	242.0	1	2	0.004	0.008
1701-1800	242.6	5	14	0.021	0.058
1801-1900	242.0	2	6	0.008	0.025
1901-2000	239.9	5	18	0.021	0.075
2001-2100	237.8	9	36	0.038	0.151
2101-2200	236.5	3	10	0.013	0.042
2201-2300	233.9	3	12	0.013	0.051
2301-2400	230.0	3	10	0.013	0.043
2401-2500	225.1	5	20	0.022	0.089
2501-2600	215.3	8	29	0.037	0.135
2601-2700	203.1	9	33	0.044	0.162
2701-2800	194.5	19	76	0.098	0.391
2801-2900	188.4	16	58	0.085	0.308
2901-3000	177.0	13	41	0.073	0.232
3001-3100	164.8	3	12	0.018	0.073
3101-3200	144.7	6	22	0.041	0.152
3201-3300	124.5	3	8	0.024	0.064
3301-3400	107.0	1	2	0.009	0.019

TABLE B39

Replacement Rates for Starters on M60 Tanks in 3d Armd Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	18.0	0	0	0.000	0.000
101-200	18.0	1	1	0.056	0.056
201-300	20.2	5	5	0.248	0.248
301-400	31.3	2	2	0.064	0.064
401-500	60.7	2	2	0.033	0.033
501-600	97.2	1	1	0.010	0.010
601-700	144.1	1	1	0.007	0.007
701-800	180.4	6	6	0.033	0.033
801-900	211.4	3	3	0.014	0.014
901-1000	222.2	8	8	0.036	0.036
1001-1100	223.0	10	10	0.045	0.045
1101-1200	223.6	9	9	0.040	0.040
1201-1300	224.6	4	4	0.018	0.018
1301-1400	229.9	8	8	0.035	0.035
1401-1500	234.5	7	7	0.030	0.030
1501-1600	238.0	11	11	0.046	0.046
1601-1700	242.0	4	4	0.017	0.017
1701-1800	242.6	4	4	0.016	0.016
1801-1900	242.0	3	3	0.012	0.012
1901-2000	239.9	3	3	0.013	0.013
2001-2100	237.8	5	5	0.021	0.021
2101-2200	236.5	6	6	0.025	0.025
2201-2300	233.9	3	3	0.013	0.013
2301-2400	230.0	7	7	0.030	0.030
2401-2500	225.1	4	4	0.018	0.018
2501-2600	215.3	1	1	0.005	0.005
2601-2700	203.1	6	6	0.030	0.030
2701-2800	194.5	2	2	0.010	0.010
2801-2900	188.4	5	5	0.027	0.027
2901-3000	177.0	4	4	0.023	0.023
3001-3100	164.8	3	3	0.018	0.018
3101-3200	144.7	3	3	0.021	0.021
3201-3300	124.5	0	0	0.000	0.000
3301-3400	107.0	1	1	0.009	0.009
3401-3500	96.6	1	1	0.010	0.010
3501-3600	85.5	3	3	0.035	0.035
3601-3700	75.2	1	1	0.013	0.013
3701-3800	61.5	0	0	0.000	0.000
3801-3900	51.3	1	1	0.019	0.019

TABLE B40

Replacement Rates for Road and Idler Wheels on M60 Tanks in 3d Armd Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	18.0	0	0	0.000	0.000
101-200	18.0	0	0	0.000	0.000
201-300	20.2	0	0	0.000	0.000
301-400	31.3	0	0	0.000	0.000
401-500	60.7	1	1	0.016	0.016
501-600	97.2	0	0	0.000	0.000
601-700	144.1	0	0	0.000	0.000
701-800	180.4	0	0	0.000	0.000
801-900	211.4	1	2	0.005	0.009
901-1000	222.2	1	2	0.005	0.009
1001-1100	223.0	1	2	0.004	0.009
1101-1200	223.6	0	0	0.000	0.000
1201-1300	224.6	1	2	0.004	0.009
1301-1400	229.9	1	1	0.004	0.004
1401-1500	234.5	1	1	0.004	0.004
1501-1600	238.0	2	4	0.008	0.017
1601-1700	242.0	0	0	0.000	0.000
1701-1800	242.6	1	2	0.004	0.008
1801-1900	242.0	2	4	0.008	0.017
1901-2000	239.9	4	8	0.017	0.033
2001-2100	237.8	4	10	0.017	0.042
2101-2200	236.5	1	1	0.004	0.004
2201-2300	233.9	5	11	0.021	0.047
2301-2400	230.0	1	4	0.004	0.017
2401-2500	225.1	3	6	0.013	0.027
2501-2600	215.3	3	8	0.014	0.037
2601-2700	203.1	9	31	0.044	0.153
2701-2800	194.5	7	18	0.036	0.093
2801-2900	188.4	12	22	0.064	0.117
2901-3000	177.0	9	40	0.051	0.226
3001-3100	164.8	8	16	0.049	0.097
3101-3200	144.7	4	6	0.028	0.041
3201-3300	124.5	3	15	0.024	0.120
3301-3400	107.0	4	8	0.037	0.075
3401-3500	96.6	1	1	0.010	0.010
3501-3600	85.5	3	9	0.035	0.105
3601-3700	75.2	4	15	0.053	0.199
3701-3800	61.5	4	6	0.065	0.098
3801-3900	51.3	3	4	0.058	0.078
3901-4000	44.1	3	6	0.068	0.136
4001-4100	37.0	3	12	0.081	0.324
4101-4200	29.0	0	0	0.000	0.000
4201-4300	20.4	2	3	0.098	0.147
4301-4400	15.4	4	10	0.260	0.649
4401-4500	10.6	2	2	0.189	0.189

IN 1st BN, 33d ARMOR, BASED ON MILES OF OPERATION

TABLE B41

Replacement Rates for Engines on M60 Tanks in 1st Bn, 33d Armor

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	77.0	1	1	0.013	0.013
101-200	77.0	0	0	0.000	0.000
201-300	76.0	2	2	0.026	0.026
301-400	76.0	0	0	0.000	0.000
401-500	74.0	0	0	0.000	0.000
501-600	74.0	0	0	0.000	0.000
601-700	74.0	0	0	0.000	0.000
701-800	74.0	0	0	0.000	0.000
801-900	73.0	0	0	0.000	0.000
901-1000	73.0	0	0	0.000	0.000
1001-1100	73.0	0	0	0.000	0.000
1101-1200	73.0	0	0	0.000	0.000
1201-1300	73.0	0	0	0.000	0.000
1301-1400	73.0	0	0	0.000	0.000
1401-1500	73.0	0	0	0.000	0.000
1501-1600	73.0	0	0	0.000	0.000
1601-1700	73.0	0	0	0.000	0.000
1701-1800	73.0	1	1	0.014	0.014
1801-1900	73.0	1	1	0.014	0.014
1901-2000	73.0	0	0	0.000	0.000
2001-2100	73.0	0	0	0.000	0.000
2101-2200	73.0	1	1	0.014	0.014
2201-2300	72.7	0	0	0.000	0.000
2301-2400	72.0	2	2	0.028	0.028
2401-2500	72.0	1	1	0.014	0.014
2501-2600	72.0	1	1	0.014	0.014
2601-2700	72.0	1	1	0.014	0.014
2701-2800	72.0	3	3	0.042	0.042
2801-2900	72.0	1	1	0.014	0.014
2901-3000	71.4	0	0	0.000	0.000
3001-3100	71.0	2	2	0.028	0.028
3101-3200	71.0	2	2	0.028	0.028
3201-3300	71.0	2	2	0.028	0.028
3301-3400	71.0	2	2	0.028	0.028
3401-3500	71.0	2	2	0.028	0.028
3501-3600	69.5	1	1	0.014	0.014
3601-3700	65.8	2	2	0.030	0.030
3701-3800	56.8	1	1	0.018	0.018
3801-3900	49.7	1	1	0.020	0.020
3901-4000	44.0	1	1	0.023	0.023
4001-4100	37.0	2	2	0.054	0.054
4101-4200	29.0	0	0	0.000	0.000
4201-4300	20.4	1	1	0.049	0.049

TABLE B41 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	76.0	3	3	0.039	0.039
501-1000	73.6	0	0	0.000	0.000
1001-1500	73.0	0	0	0.000	0.000
1501-2000	73.0	2	2	0.027	0.027
2001-2500	72.7	4	4	0.055	0.055
2501-3000	71.9	6	6	0.083	0.083
3001-3500	71.0	10	10	0.141	0.141
3501-4000	57.2	6	6	0.105	0.105
4001-4500	22.5	3	3	0.133	0.133

TABLE B42

Replacement Rates for Track Shoes on M60 Tanks in 1st Bn, 33d Armor

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-100	11.0	0	0	0.000	0.000
101-200	11.0	0	0	0.000	0.000
201-300	12.9	0	0	0.000	0.000
301-400	20.4	0	0	0.000	0.000
401-500	27.7	0	0	0.000	0.000
501-600	37.7	0	0	0.000	0.000
601-700	48.9	0	0	0.000	0.000
701-800	51.6	0	0	0.000	0.000
801-900	53.4	0	0	0.000	0.000
901-1000	54.7	0	0	0.000	0.000
1001-1100	54.0	0	0	0.000	0.000
1101-1200	54.0	0	0	0.000	0.000
1201-1300	54.5	0	0	0.000	0.000
1301-1400	59.9	0	0	0.000	0.000
1401-1500	63.5	0	0	0.000	0.000
1501-1600	67.0	0	0	0.000	0.000
1601-1700	71.7	1	162	0.014	2.259
1701-1800	73.0	2	324	0.027	4.438
1801-1900	73.0	3	486	0.041	6.411
1901-2000	73.0	6	889	0.082	12.178
2001-2100	73.0	6	972	0.082	13.315
2101-2200	73.0	8	1296	0.110	17.753
2201-2300	72.7	15	2430	0.206	33.425
2301-2400	72.0	12	1944	0.167	27.000
2401-2500	72.0	9	1138	0.125	15.806
2501-2600	72.0	7	972	0.097	13.500
2601-2700	72.0	3	405	0.042	5.625
2701-2800	72.0	2	324	0.028	4.500
2801-2900	72.0	3	484	0.042	6.722
2901-3000	71.4	7	1130	0.098	15.826
3001-3100	71.0	5	649	0.070	9.141
3101-3200	71.0	3	484	0.042	6.817
3201-3300	71.0	4	509	0.056	7.169
3301-3400	71.0	6	810	0.085	11.408
3401-3500	71.0	4	77	0.056	1.085
3501-3600	69.5	5	660	0.072	9.496
3601-3700	65.8	3	482	0.046	7.325
3701-3800	56.8	3	480	0.053	8.451
3801-3900	49.7	9	973	0.181	19.577
3901-4000	44.0	3	482	0.068	10.955
4001-4100	37.0	4	484	0.108	13.081
4101-4200	29.0	3	321	0.103	11.069
4201-4300	20.4	1	162	0.049	7.941
4301-4400	15.4	1	160	0.065	10.390
4401-4500	10.6	0	0	0.000	0.000
4501-4600	9.1	2	166	0.220	18.242

TABLE B42 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	16.6	0	0	0.000	0.000
501-1000	49.3	0	0	0.000	0.000
1001-1500	57.2	0	0	0.000	0.000
1501-2000	71.5	12	1861	0.168	26.028
2001-2500	72.5	50	7780	0.690	107.310
2501-3000	71.9	22	3315	0.306	46.106
3001-3500	71.0	22	2529	0.310	35.620
3501-4000	57.2	23	3077	0.402	53.794
4001-4500	22.5	9	1127	0.400	50.089

TABLE B43

Replacement Rates for Sprockets on M60 Tanks in 1st Bn, 33d Armor

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	11.0	0	0	0.000	0.000
101-200	11.0	0	0	0.000	0.000
201-300	12.9	0	0	0.000	0.000
301-400	20.4	0	0	0.000	0.000
401-500	27.7	0	0	0.000	0.000
501-600	37.7	0	0	0.000	0.000
601-700	48.9	0	0	0.000	0.000
701-800	51.6	0	0	0.000	0.000
801-900	53.4	0	0	0.000	0.000
901-1000	54.7	0	0	0.000	0.000
1001-1100	54.0	0	0	0.000	0.000
1101-1200	54.0	0	0	0.000	0.000
1201-1300	54.5	0	0	0.000	0.000
1301-1400	59.9	0	0	0.000	0.000
1401-1500	63.5	0	0	0.000	0.000
1501-1600	67.0	0	0	0.000	0.000
1601-1700	71.7	0	0	0.000	0.000
1701-1800	73.0	1	4	0.014	0.055
1801-1900	73.0	0	0	0.000	0.000
1901-2000	73.0	0	0	0.000	0.000
2001-2100	73.0	0	0	0.000	0.000
2101-2200	73.0	2	6	0.027	0.082
2201-2300	72.7	2	8	0.028	0.110
2301-2400	72.0	2	8	0.028	0.111
2401-2500	72.0	3	12	0.042	0.167
2501-2600	72.0	6	24	0.083	0.333
2601-2700	72.0	7	28	0.097	0.389
2701-2800	72.0	13	52	0.181	0.722
2801-2900	72.0	13	52	0.181	0.722
2901-3000	71.4	6	24	0.084	0.336
3001-3100	71.0	1	4	0.014	0.056
0-500	16.6	0	0	0.000	0.000
501-1000	49.3	0	0	0.000	0.000
1001-1500	57.2	0	0	0.000	0.000
1501-2000	71.5	1	4	0.014	0.056
2001-2500	72.5	9	34	0.124	0.469
2501-3000	71.9	45	180	0.626	2.503

TABLE B-4

Replacement Rates for Starters on M60 Tanks in 1st Bn, 33d Armor

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	11.0	0	0	0.000	0.000
101-200	11.0	1	1	0.100	0.100
201-300	12.9	5	5	0.388	0.388
301-400	20.4	2	2	0.098	0.098
401-500	27.7	2	2	0.072	0.072
501-600	37.7	0	0	0.000	0.000
601-700	48.9	0	0	0.000	0.000
701-800	51.6	0	0	0.000	0.000
801-900	53.4	0	0	0.000	0.000
901-1000	54.7	0	0	0.000	0.000
1001-1100	54.0	0	0	0.000	0.000
1101-1200	54.0	0	0	0.000	0.000
1201-1300	54.5	0	0	0.000	0.000
1301-1400	59.9	1	1	0.017	0.017
1401-1500	63.5	1	1	0.016	0.016
1501-1600	67.0	5	5	0.075	0.075
1601-1700	71.7	1	1	0.014	0.014
1701-1800	73.0	0	0	0.000	0.000
1801-1900	73.0	1	1	0.014	0.014
1901-2000	73.0	1	1	0.014	0.014
2001-2100	73.0	0	0	0.000	0.000
2101-2200	73.0	1	1	0.014	0.014
2201-2300	73.0	1	1	0.014	0.014
2301-2400	72.0	1	1	0.014	0.014
2401-2500	72.0	1	1	0.014	0.014
2501-2600	72.0	0	0	0.000	0.000
2601-2700	72.0	3	3	0.042	0.042
2701-2800	72.0	1	1	0.014	0.014
2801-2900	72.0	0	0	0.000	0.000
2901-3000	71.4	1	1	0.014	0.014
3001-3100	71.0	0	0	0.000	0.000
3101-3200	71.0	0	0	0.000	0.000
3201-3300	71.0	0	0	0.000	0.000
3301-3400	71.0	0	0	0.000	0.000
3401-3500	71.0	0	0	0.000	0.000
3501-3600	69.5	2	2	0.029	0.029
3601-3700	65.8	1	1	0.015	0.015
3701-3800	56.8	0	0	0.000	0.000
3801-3900	49.7	1	1	0.020	0.020
3901-4000	44.0	0	0	0.000	0.000

TABLE B44 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	16.6	10	10	0.602	0.602
501-1000	49.3	0	0	0.000	0.000
1001-1500	57.2	2	2	0.035	0.035
1501-2000	71.5	8	8	0.112	0.112
2001-2500	72.5	4	4	0.055	0.055
2501-3000	71.9	5	5	0.070	0.070
3001-3500	71.0	0	0	0.000	0.000
3501-4000	57.2	4	4	0.070	0.070

TABLE B45

Replacement Rates for Road and Idler Wheels on M60 Tanks in 1st Bn, 33d Armor

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	11.0	0	0	0.000	0.000
101-200	11.0	0	0	0.000	0.000
201-300	12.9	0	0	0.000	0.000
301-400	20.4	0	0	0.000	0.000
401-500	27.7	1	1	0.036	0.036
501-600	37.7	0	0	0.000	0.000
601-700	48.9	0	0	0.000	0.000
701-800	51.6	0	0	0.000	0.000
801-900	53.4	0	0	0.000	0.000
901-1000	54.7	0	0	0.000	0.000
1001-1100	54.0	1	2	0.019	0.037
1101-1200	54.0	0	0	0.000	0.000
1201-1300	54.5	0	0	0.000	0.000
1301-1400	59.9	0	0	0.000	0.000
1401-1500	63.5	0	0	0.000	0.000
1501-1600	67.0	0	0	0.000	0.000
1601-1700	71.7	0	0	0.000	0.000
1701-1800	73.0	1	2	0.014	0.027
1801-1900	73.0	1	2	0.014	0.027
1901-2000	73.0	1	4	0.014	0.055
2001-2100	73.0	0	0	0.000	0.000
2101-2200	73.0	0	0	0.000	0.000
2201-2300	72.7	3	4	0.041	0.055
2301-2400	72.0	0	0	0.000	0.000
2401-2500	72.0	2	4	0.028	0.056
2501-2600	72.0	1	2	0.014	0.028
2601-2700	72.0	1	1	0.014	0.014
2701-2800	72.0	3	4	0.042	0.056
2801-2900	72.0	2	2	0.028	0.028
2901-3000	71.4	2	6	0.028	0.084
3001-3100	71.0	1	2	0.014	0.028
3101-3200	71.0	1	2	0.014	0.028
3201-3300	71.0	2	3	0.028	0.042
3301-3400	71.0	0	0	0.000	0.000
3401-3500	71.0	0	0	0.000	0.000
3501-3600	69.5	3	9	0.043	0.129
3601-3700	65.8	4	15	0.061	0.228
3701-3800	56.8	4	6	0.070	0.106
3801-3900	49.7	3	4	0.060	0.080
3901-4000	44.0	3	6	0.068	0.136

TABLE B45 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	16.6	1	1	0.060	0.060
501-1000	49.3	0	0	0.000	0.000
1001-1500	57.2	1	2	0.017	0.035
1501-2000	71.5	3	8	0.042	0.112
2001-2500	72.5	5	8	0.069	0.110
2501-3000	71.9	9	15	0.125	0.209
3001-3500	71.0	4	7	0.056	0.099
3501-4000	57.2	17	40	0.297	0.699

M113 APCs

TABLE B46

FSNs of M113 APC Repair Parts Studied

Noun of repair part	FSN
Battery, storage	6140-057-2554
Coil, ignition	2920-324-0371
Differential, steering control	2520-714-6135
Distributor, ignition system	2920-679-9753
Engine assembly	2805-679-9668
	2805-751-9059
Pad, shoe, track	2530-690-2681
Radiator, engine coolant	2930-679-9748
	2930-811-9168
Seal, road wheel hub	5330-679-9879
Shock absorber, direct action	2540-714-6156
Shoe, track	2530-690-2682
Spark plug	2920-679-9728
Sprocket, wheel, track drive	2520-679-7956
Starter, engine, electrical	2920-784-1708
Transmission assembly, automatic	2520-679-8032
	2520-860-7342
Wheel, track idler, rubber; steel	2530-711-0375
	2530-856-2299
Wheel, road, rubber	2530-679-7973

IN USAREUR, BASED ON MILES OF OPERATION

TABLE B47

Replacement Rates for Batteries on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	2	3	0.004	0.006
201-300	466.0	1	2	0.002	0.004
301-400	466.5	0	0	0.000	0.000
401-500	469.2	0	0	0.000	0.000
501-600	475.8	1	1	0.002	0.002
601-700	488.3	1	1	0.002	0.002
701-800	501.1	0	0	0.000	0.000
801-900	507.1	6	9	0.012	0.018
901-1000	513.0	1	1	0.002	0.002
1001-1100	517.1	2	2	0.004	0.004
1101-1200	520.1	0	0	0.000	0.000
1201-1300	528.5	5	7	0.009	0.013
1301-1400	525.8	6	8	0.011	0.015
1401-1500	532.3	4	8	0.008	0.015
1501-1600	538.5	3	5	0.006	0.009
1601-1700	532.6	6	8	0.011	0.015
1701-1800	514.2	6	8	0.012	0.016
1801-1900	495.1	3	3	0.006	0.006
1901-2000	487.8	6	6	0.012	0.012
2001-2100	482.0	6	8	0.012	0.017
2101-2200	463.6	7	10	0.015	0.022
2201-2300	440.7	3	5	0.007	0.011
2301-2400	417.6	5	8	0.012	0.019
2401-2500	402.0	6	11	0.015	0.027
2501-2600	378.3	5	5	0.013	0.013
2601-2700	343.2	7	9	0.020	0.026
2701-2800	317.0	7	9	0.022	0.028
2801-2900	287.7	1	1	0.003	0.003
2901-3000	257.8	5	7	0.019	0.027
3001-3100	232.7	4	5	0.017	0.021
3101-3200	207.1	7	10	0.034	0.048
3201-3300	181.0	8	9	0.044	0.050
3301-3400	159.7	5	7	0.031	0.044
3401-3500	140.4	7	7	0.050	0.050
3501-3600	122.1	6	8	0.049	0.066
3601-3700	102.0	2	3	0.020	0.029
3701-3800	85.2	5	7	0.059	0.082
3801-3900	72.7	1	1	0.014	0.014

TABLE B48

Replacement Rates for Ignition Coils on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	1	1	0.002	0.002
201-300	466.0	1	1	0.002	0.002
301-400	466.5	0	0	0.000	0.000
401-500	469.2	1	1	0.002	0.002
501-600	475.8	1	1	0.002	0.002
601-700	488.3	3	3	0.006	0.006
701-800	501.1	1	1	0.002	0.002
801-900	507.1	0	0	0.000	0.000
901-1000	513.0	4	4	0.008	0.008
1001-1100	517.1	3	3	0.006	0.006
1101-1200	520.1	4	4	0.008	0.008
1201-1300	528.5	4	4	0.008	0.008
1301-1400	525.8	4	4	0.008	0.008
1401-1500	532.3	4	4	0.008	0.008
1501-1600	538.5	6	6	0.011	0.011
1601-1700	532.6	3	3	0.006	0.006
1701-1800	514.2	5	5	0.010	0.010
1801-1900	495.1	2	2	0.004	0.004
1901-2000	487.8	3	3	0.006	0.006
2001-2100	482.0	4	4	0.008	0.008
2101-2200	463.6	3	3	0.006	0.006
2201-2300	440.7	5	5	0.011	0.011
2301-2400	417.6	4	4	0.010	0.010
2401-2500	402.0	4	4	0.010	0.010
2501-2600	378.3	4	4	0.011	0.011
2601-2700	343.2	5	5	0.015	0.015
2701-2800	317.0	2	2	0.006	0.006
2801-2900	287.7	3	3	0.010	0.010
2901-3000	257.8	2	2	0.008	0.008
3001-3100	232.7	0	0	0.000	0.000
3101-3200	207.1	3	3	0.014	0.014
3201-3300	181.0	2	2	0.011	0.011
3301-3400	159.7	0	0	0.000	0.000
3401-3500	140.4	3	3	0.021	0.021
3501-3600	122.1	2	2	0.016	0.016
3601-3700	102.0	2	2	0.020	0.020
3701-3800	85.2	2	2	0.023	0.023
3801-3900	72.7	1	1	0.014	0.014
3901-4000	59.5	1	1	0.017	0.017
4001-4100	49.7	2	2	0.040	0.040

TABLE B49

Replacement Rates for Differentials on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	1	1	0.002	0.002
201-300	466.0	1	1	0.002	0.002
301-400	466.5	0	0	0.000	0.000
401-500	469.2	2	2	0.004	0.004
501-600	475.8	0	0	0.000	0.000
601-700	488.3	2	2	0.004	0.004
701-800	501.1	0	0	0.000	0.000
801-900	507.1	1	1	0.002	0.002
901-1000	513.0	4	4	0.008	0.008
1001-1100	517.1	3	3	0.006	0.006
1101-1200	520.1	5	5	0.010	0.010
1201-1300	528.5	3	3	0.006	0.006
1301-1400	525.8	3	3	0.006	0.006
1401-1500	532.3	4	4	0.008	0.008
1501-1600	538.5	3	3	0.006	0.006
1601-1700	532.6	3	3	0.006	0.006
1701-1800	514.2	1	1	0.002	0.002
1801-1900	495.1	3	3	0.006	0.006
1901-2000	487.8	2	2	0.004	0.004
2001-2100	482.0	2	2	0.004	0.004
2101-2200	463.6	1	1	0.002	0.002
2201-2300	440.7	1	1	0.002	0.002
2301-2400	417.6	4	4	0.010	0.010
2401-2500	402.0	1	1	0.002	0.002
2501-2600	378.3	0	0	0.000	0.000
2601-2700	343.2	1	1	0.003	0.003
2701-2800	317.0	1	1	0.003	0.003
2801-2900	287.7	0	0	0.000	0.000
2901-3000	257.8	1	1	0.004	0.004

TABLE B50

Replacement Rates for Distributors on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	0	0	0.000	0.000
301-400	466.5	0	0	0.000	0.000
401-500	469.2	1	1	0.002	0.002
501-600	475.8	0	0	0.000	0.000
601-700	488.3	1	1	0.002	0.002
701-800	501.1	0	0	0.000	0.000
801-900	507.1	3	3	0.006	0.006
901-1000	513.0	3	3	0.006	0.006
1001-1100	517.1	4	4	0.008	0.008
1101-1200	520.1	5	5	0.010	0.010
1201-1300	528.5	4	4	0.008	0.008
1301-1400	525.8	4	4	0.008	0.008
1401-1500	532.3	5	5	0.009	0.009
1501-1600	538.5	1	1	0.002	0.002
1601-1700	532.6	4	4	0.008	0.008
1701-1800	514.2	6	6	0.012	0.012
1801-1900	495.1	11	11	0.022	0.022
1901-2000	487.8	5	5	0.010	0.010
2001-2100	482.0	5	5	0.010	0.010
2101-2200	463.6	7	7	0.015	0.015
2201-2300	440.7	4	4	0.009	0.009
2301-2400	417.6	4	4	0.010	0.010
2401-2500	402.0	2	2	0.005	0.005
2501-2600	378.3	8	8	0.021	0.021
2601-2700	343.2	1	1	0.003	0.003
2701-2800	317.0	3	3	0.009	0.009
2801-2900	287.7	3	3	0.010	0.010
2901-3000	257.8	2	2	0.008	0.008
3001-3100	232.7	4	4	0.017	0.017
3101-3200	207.1	3	3	0.014	0.014
3201-3300	181.0	1	1	0.006	0.006
3301-3400	159.7	0	0	0.000	0.000
3401-3500	140.4	4	4	0.028	0.028
3501-3600	122.1	2	2	0.016	0.016
3601-3700	102.0	1	1	0.010	0.010
3701-3800	85.2	2	2	0.023	0.023
3801-3900	72.7	0	0	0.000	0.000
3901-4000	59.5	1	1	0.017	0.017
4001-4100	49.7	2	2	0.040	0.040
4101-4200	37.9	1	1	0.026	0.026
4201-4300	27.8	1	1	0.036	0.036

TABLE B51

Replacement Rates for Engines on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	705.0	0	0	0.000	0.000
101-200	705.0	2	2	0.003	0.003
201-300	705.0	1	1	0.001	0.001
301-400	705.0	2	2	0.003	0.003
401-500	705.0	0	0	0.000	0.000
501-600	705.0	2	2	0.003	0.003
601-700	705.0	1	1	0.001	0.001
701-800	704.1	0	0	0.000	0.000
801-900	701.3	4	4	0.006	0.006
901-1000	694.7	2	2	0.003	0.003
1001-1100	689.0	0	0	0.000	0.000
1101-1200	683.4	1	1	0.001	0.001
1201-1300	675.6	2	2	0.003	0.003
1301-1400	660.6	1	1	0.002	0.002
1401-1500	645.7	2	2	0.003	0.003
1501-1600	632.8	4	4	0.006	0.006
1601-1700	613.1	3	3	0.005	0.005
1701-1800	579.9	3	3	0.005	0.005
1801-1900	551.3	5	5	0.009	0.009
1901-2000	532.9	5	5	0.009	0.009
2001-2100	515.4	8	8	0.016	0.016
2101-2200	490.8	2	2	0.004	0.004
2201-2300	463.1	1	1	0.002	0.002
2301-2400	434.4	2	2	0.005	0.005
2401-2500	411.0	8	8	0.019	0.019
2501-2600	382.2	3	3	0.008	0.008
2601-2700	345.7	5	5	0.014	0.014
2701-2800	318.5	3	3	0.009	0.009
2801-2900	288.7	3	3	0.010	0.010
2901-3000	258.8	5	5	0.019	0.019
3001-3100	232.8	4	4	0.017	0.017
3101-3200	207.1	2	2	0.010	0.010
3201-3300	181.0	0	0	0.000	0.000
3301-3400	159.7	0	0	0.000	0.000
3401-3500	140.4	3	3	0.021	0.021
3501-3600	122.1	4	4	0.033	0.033
3601-3700	102.0	2	2	0.020	0.020
3701-3800	85.2	0	0	0.000	0.000
3801-3900	72.7	1	1	0.014	0.014
3901-4000	59.5	1	1	0.017	0.017

TABLE B52

Replacement Rates for Track Pads on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	2	3	0.004	0.006
301-400	466.5	1	2	0.002	0.004
401-500	469.2	1	1	0.002	0.002
501-600	475.8	5	135	0.011	0.284
601-700	488.3	1	1	0.002	0.002
701-800	501.1	4	134	0.008	0.267
801-900	507.1	5	187	0.010	0.369
901-1000	513.0	0	0	0.000	0.000
1001-1100	517.1	4	269	0.008	0.520
1101-1200	520.1	11	782	0.021	1.504
1201-1300	528.5	8	275	0.015	0.520
1301-1400	525.8	14	301	0.027	0.572
1401-1500	532.3	10	337	0.019	0.633
1501-1600	538.5	9	709	0.017	1.317
1601-1700	532.6	13	778	0.024	1.461
1701-1800	514.2	14	1148	0.027	2.233
1801-1900	495.1	11	901	0.022	1.820
1901-2000	487.8	17	1658	0.035	3.399
2001-2100	482.0	16	1661	0.033	3.446
2101-2200	463.6	21	2305	0.045	4.972
2201-2300	440.7	23	2665	0.052	6.047
2301-2400	417.6	12	1393	0.029	3.336
2401-2500	402.0	20	2359	0.050	5.868
2501-2600	378.3	19	1827	0.050	4.830
2601-2700	343.2	11	1146	0.032	3.339
2701-2800	317.0	13	1523	0.041	4.804
2801-2900	287.7	14	1401	0.049	4.870
2901-3000	257.8	9	800	0.035	3.103
3001-3100	232.7	7	513	0.030	2.205
3101-3200	207.1	5	509	0.024	2.458
3201-3300	181.0	14	1250	0.077	6.906
3301-3400	159.7	6	758	0.038	4.746
3401-3500	140.4	9	784	0.064	5.584
3501-3600	122.1	16	1502	0.131	12.301
3601-3700	102.0	10	1206	0.098	11.824
3701-3800	85.2	6	572	0.070	6.714
3801-3900	72.7	3	256	0.041	3.521
3901-4000	59.5	0	0	0.000	0.000
4001-4100	49.7	4	382	0.080	7.686
4101-4200	37.9	0	0	0.000	0.000
4201-4300	27.8	2	189	0.072	6.799
4301-4400	19.6	3	381	0.153	19.439

TABLE B53

Replacement Rates for Radiators on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	0	0	0.000	0.000
301-400	466.5	1	1	0.002	0.002
401-500	469.2	0	0	0.000	0.000
501-600	475.8	1	1	0.002	0.002
601-700	488.3	1	1	0.002	0.002
701-800	501.1	1	1	0.002	0.002
801-900	507.1	0	0	0.000	0.000
901-1000	513.0	1	1	0.002	0.002
1001-1100	517.1	2	2	0.004	0.004
1101-1200	520.1	2	2	0.004	0.004
1201-1300	528.5	0	0	0.000	0.000
1301-1400	525.8	4	4	0.008	0.008
1401-1500	532.3	1	1	0.002	0.002
1501-1600	538.5	0	0	0.000	0.000
1601-1700	532.6	1	1	0.002	0.002
1701-1800	514.2	3	3	0.006	0.006
1801-1900	495.1	4	4	0.008	0.008
1901-2000	487.8	4	4	0.008	0.008
2001-2100	482.0	5	5	0.010	0.010
2101-2200	463.6	2	2	0.004	0.004
2201-2300	440.7	7	7	0.016	0.016
2301-2400	417.6	4	4	0.010	0.010
2401-2500	402.0	2	2	0.005	0.005
2501-2600	378.3	1	1	0.003	0.003
2601-2700	343.2	6	6	0.017	0.017
2701-2800	317.0	0	0	0.000	0.000
2801-2900	287.7	1	1	0.003	0.003
2901-3000	257.8	2	2	0.008	0.008
3001-3100	232.7	1	1	0.004	0.004
3101-3200	207.1	1	1	0.005	0.005
3201-3300	181.0	1	1	0.006	0.006
3301-3400	159.7	1	1	0.006	0.006
3401-3500	140.4	1	1	0.007	0.007
3501-3600	122.1	1	1	0.008	0.008
3601-3700	102.0	2	2	0.020	0.020
3701-3800	85.2	0	0	0.000	0.000
3801-3900	72.7	1	1	0.014	0.014
3901-4000	59.5	0	0	0.000	0.000
4001-4100	49.7	1	1	0.020	0.020

TABLE B54

Replacement Rates for Road Wheel Hub Seals on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	1	1	0.002	0.002
201-300	466.0	0	0	0.000	0.000
301-400	466.5	0	0	0.000	0.000
401-500	469.2	0	0	0.000	0.000
501-600	475.8	1	1	0.002	0.002
601-700	488.3	3	3	0.006	0.006
701-800	501.1	2	8	0.004	0.016
801-900	507.1	1	1	0.002	0.002
901-1000	513.0	0	0	0.000	0.000
1001-1100	517.1	3	6	0.006	0.012
1101-1200	520.1	4	5	0.008	0.010
1201-1300	528.5	3	3	0.006	0.006
1301-1400	525.8	2	2	0.004	0.004
1401-1500	532.3	0	0	0.000	0.000
1501-1600	538.5	2	2	0.004	0.004
1601-1700	532.6	3	4	0.006	0.008
1701-1800	514.2	1	1	0.002	0.002
1801-1900	495.1	2	2	0.004	0.004
1901-2000	487.8	1	1	0.002	0.002
2001-2100	482.0	6	11	0.012	0.023
2101-2200	463.6	7	7	0.015	0.015
2201-2300	440.7	2	4	0.005	0.009
2301-2400	417.6	3	3	0.007	0.007
2401-2500	402.0	2	2	0.005	0.005
2501-2600	378.3	2	2	0.005	0.005
2601-2700	343.2	3	3	0.009	0.009
2701-2800	317.0	0	0	0.000	0.000
2801-2900	287.7	1	1	0.003	0.003
2901-3000	257.8	3	5	0.012	0.019
3001-3100	232.7	1	8	0.004	0.034
3101-3200	207.1	1	2	0.005	0.010
3201-3300	181.0	1	1	0.006	0.006
3301-3400	159.7	1	2	0.006	0.013
3401-3500	140.4	3	4	0.021	0.028
3501-3600	122.1	0	0	0.000	0.000
3601-3700	102.0	4	4	0.039	0.039
3701-3800	85.2	0	0	0.000	0.000
3801-3900	72.7	0	0	0.000	0.000
3901-4000	59.5	3	5	0.050	0.084
4001-4100	49.7	2	4	0.040	0.080

TABLE B55

Replacement Rates for Shock Absorbers on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	1	1	0.002	0.002
301-400	466.5	0	0	0.000	0.000
401-500	469.2	1	1	0.002	0.002
501-600	475.8	0	0	0.000	0.000
601-700	488.3	2	2	0.004	0.004
701-800	501.1	0	0	0.000	0.000
801-900	507.1	2	2	0.004	0.004
901-1000	513.0	0	0	0.000	0.000
1001-1100	517.1	1	1	0.002	0.002
1101-1200	520.1	1	1	0.002	0.002
1201-1300	528.5	4	4	0.008	0.008
1301-1400	525.8	3	3	0.006	0.006
1401-1500	532.3	2	4	0.004	0.008
1501-1600	538.5	1	1	0.002	0.002
1601-1700	532.6	1	1	0.002	0.002
1701-1800	514.2	6	6	0.012	0.012
1801-1900	495.1	2	2	0.004	0.004
1901-2000	487.8	2	2	0.004	0.004
2001-2100	482.0	4	6	0.008	0.012
2101-2200	463.6	8	15	0.017	0.032
2201-2300	440.7	3	8	0.007	0.018
2301-2400	417.6	8	11	0.019	0.026
2401-2500	402.0	9	11	0.022	0.027
2501-2600	378.3	6	10	0.016	0.026
2601-2700	343.2	3	5	0.009	0.015
2701-2800	317.0	2	3	0.006	0.009
2801-2900	287.7	5	5	0.017	0.017
2901-3000	257.8	8	10	0.031	0.039
3001-3100	232.7	7	8	0.030	0.034
3101-3200	207.1	7	9	0.034	0.043
3201-3300	181.0	4	7	0.022	0.039
3301-3400	159.7	3	4	0.019	0.025
3401-3500	140.4	7	7	0.050	0.050
3501-3600	122.1	4	4	0.033	0.033
3601-3700	102.0	3	7	0.029	0.069
3701-3800	85.2	4	7	0.047	0.082
3801-3900	72.7	7	11	0.096	0.151
3901-4000	59.5	1	1	0.017	0.017
4001-4100	49.7	3	9	0.060	0.181
4101-4200	37.9	1	4	0.026	0.106
4201-4300	27.8	1	4	0.036	0.144

TABLE B56

Replacement Rates for Track Shoes on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-100	467.0	0	0	0.000	0.000
101-200	467.0	1	2	0.002	0.004
201-300	467.0	2	3	0.004	0.006
301-400	467.5	4	5	0.009	0.011
401-500	470.2	0	0	0.000	0.000
501-600	476.8	5	11	0.010	0.023
601-700	489.3	2	65	0.004	0.133
701-800	502.1	6	9	0.012	0.018
801-900	508.1	4	6	0.008	0.012
901-1000	514.0	2	2	0.004	0.004
1001-1100	518.1	3	8	0.006	0.015
1101-1200	521.1	6	18	0.012	0.035
1201-1300	529.5	11	42	0.021	0.079
1301-1400	526.8	7	156	0.013	0.296
1401-1500	533.3	9	185	0.017	0.347
1501-1600	539.5	4	13	0.007	0.024
1601-1700	533.6	9	10	0.017	0.019
1701-1800	515.2	3	19	0.006	0.037
1801-1900	496.1	8	325	0.016	0.655
1901-2000	488.8	11	661	0.023	1.352
2001-2100	483.0	6	637	0.012	1.319
2101-2200	464.6	11	645	0.024	1.388
2201-2300	441.7	8	390	0.018	0.883
2301-2400	418.6	9	265	0.022	0.633
2401-2500	403.0	8	394	0.020	0.978
2501-2600	379.3	11	547	0.029	1.442
2601-2700	344.2	10	659	0.029	1.915
2701-2800	318.0	14	1167	0.044	3.670
2801-2900	288.7	13	1085	0.045	3.758
2901-3000	258.8	17	730	0.066	2.821
3001-3100	233.7	17	635	0.073	2.717
3101-3200	208.1	11	825	0.053	3.964
3201-3300	182.0	11	1123	0.060	6.170
3301-3400	160.7	11	783	0.068	4.872
3401-3500	141.4	10	789	0.071	5.580
3501-3600	123.1	17	1706	0.138	13.859
3601-3700	103.0	12	1300	0.117	12.621
3701-3800	86.2	7	642	0.081	7.448
3801-3900	73.7	5	582	0.068	7.897
3901-4000	60.5	4	34	0.066	0.562
4001-4100	50.5	5	445	0.099	8.812

TABLE B57

Replacement Rates for Spark Plugs on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	466.0	2	2	0.004	0.004
101-200	466.0	3	6	0.006	0.013
201-300	466.0	7	19	0.015	0.041
301-400	466.5	3	18	0.006	0.039
401-500	469.2	3	22	0.006	0.047
501-600	475.8	5	40	0.011	0.084
601-700	488.3	8	58	0.016	0.119
701-800	501.1	11	65	0.022	0.130
801-900	507.1	9	39	0.018	0.077
901-1000	513.0	8	60	0.016	0.117
1001-1100	517.1	16	86	0.031	0.166
1101-1200	520.1	11	64	0.021	0.123
1201-1300	528.5	17	110	0.032	0.208
1301-1400	525.8	13	66	0.025	0.126
1401-1500	532.3	10	55	0.019	0.103
1501-1600	538.5	5	34	0.009	0.063
1601-1700	532.6	15	75	0.028	0.141
1701-1800	514.2	17	93	0.033	0.181
1801-1900	495.1	17	117	0.034	0.236
1901-2000	487.8	14	88	0.029	0.180
2001-2100	482.0	14	84	0.029	0.174
2101-2200	463.6	21	141	0.045	0.304
2201-2300	440.7	8	36	0.018	0.082
2301-2400	417.6	19	123	0.045	0.295
2401-2500	402.0	14	87	0.035	0.216
2501-2600	378.3	11	78	0.029	0.206
2601-2700	343.2	16	113	0.047	0.329
2701-2800	317.0	5	16	0.016	0.050
2801-2900	287.7	5	32	0.017	0.111
2901-3000	257.8	4	20	0.016	0.078
3001-3100	232.7	6	39	0.026	0.168
3101-3200	207.1	7	48	0.034	0.232
3201-3300	181.0	2	16	0.011	0.088
3301-3400	159.7	4	27	0.025	0.169
3401-3500	140.4	6	32	0.043	0.228
3501-3600	122.1	9	45	0.074	0.369
3601-3700	102.0	1	3	0.010	0.029
3701-3800	85.2	4	32	0.047	0.376
3801-3900	72.7	3	24	0.041	0.330
3901-4000	59.5	3	13	0.050	0.218
4001-4100	49.7	6	42	0.121	0.845
4101-4200	37.9	1	4	0.026	0.106
4201-4300	27.8	2	16	0.072	0.576

TABLE B58

Replacement Rates for Sprockets on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	0	0	0.000	0.000
301-400	466.5	0	0	0.000	0.000
401-500	469.2	0	0	0.000	0.000
501-600	475.8	1	4	0.002	0.008
601-700	488.3	0	0	0.000	0.000
701-800	501.1	0	0	0.000	0.000
801-900	507.1	0	0	0.000	0.000
901-1000	513.0	1	2	0.002	0.004
1001-1100	517.1	0	0	0.000	0.000
1101-1200	520.1	0	0	0.000	0.000
1201-1300	528.5	1	2	0.002	0.004
1301-1400	525.8	1	4	0.002	0.008
1401-1500	532.3	0	0	0.000	0.000
1501-1600	538.5	1	2	0.002	0.004
1601-1700	532.6	0	0	0.000	0.000
1701-1800	514.2	1	1	0.002	0.002
1801-1900	495.1	1	1	0.002	0.002
1901-2000	487.8	1	1	0.002	0.002
2001-2100	482.0	1	4	0.002	0.008
2101-2200	463.6	1	4	0.002	0.009
2201-2300	440.7	3	8	0.007	0.018
2301-2400	417.6	3	12	0.007	0.029
2401-2500	402.0	8	32	0.020	0.080
2501-2600	378.3	3	10	0.008	0.026
2601-2700	343.2	6	14	0.017	0.041
2701-2800	317.0	5	12	0.016	0.038
2801-2900	287.7	7	22	0.024	0.076
2901-3000	257.8	9	25	0.035	0.097
3001-3100	232.7	6	11	0.026	0.047
3101-3200	207.1	6	21	0.029	0.101
3201-3300	181.0	6	20	0.033	0.110
3301-3400	159.7	9	24	0.056	0.150
3401-3500	140.4	13	31	0.093	0.221
3501-3600	122.1	4	10	0.033	0.082
3601-3700	102.0	5	11	0.049	0.108
3701-3800	85.2	6	12	0.070	0.141
3801-3900	72.7	1	2	0.014	0.028
3901-4000	59.5	3	8	0.050	0.134
4001-4100	49.7	5	15	0.101	0.302

TABLE B59

Replacement Rates for Starters on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	3	3	0.006	0.006
101-200	466.0	5	5	0.011	0.011
201-300	466.0	1	1	0.002	0.002
301-400	466.5	4	4	0.009	0.009
401-500	469.2	4	4	0.009	0.009
501-600	475.8	10	10	0.021	0.021
601-700	488.3	10	10	0.020	0.020
701-800	501.1	3	3	0.006	0.006
801-900	507.1	13	13	0.026	0.026
901-1000	513.0	12	12	0.023	0.023
1001-1100	517.1	7	7	0.014	0.014
1101-1200	520.1	14	14	0.027	0.027
1201-1300	528.5	10	10	0.019	0.019
1301-1400	525.8	11	11	0.021	0.021
1401-1500	532.3	8	8	0.015	0.015
1501-1600	538.5	9	9	0.017	0.017
1601-1700	532.6	11	11	0.021	0.021
1701-1800	514.2	9	9	0.018	0.018
1801-1900	495.1	6	6	0.012	0.012
1901-2000	487.8	10	10	0.021	0.021
2001-2100	482.0	7	7	0.015	0.015
2101-2200	463.6	10	10	0.022	0.022
2201-2300	440.7	14	14	0.032	0.032
2301-2400	417.6	10	10	0.024	0.024
2401-2500	402.0	13	13	0.032	0.032
2501-2600	378.3	13	13	0.034	0.034
2601-2700	343.2	4	4	0.012	0.012
2701-2800	317.0	4	4	0.013	0.013
2801-2900	287.7	5	5	0.017	0.017
2901-3000	257.8	6	6	0.023	0.023
3001-3100	232.7	3	3	0.013	0.013
3101-3200	207.1	4	4	0.019	0.019
3201-3300	181.0	5	5	0.028	0.028
3301-3400	159.7	5	5	0.031	0.031
3401-3500	140.4	4	4	0.028	0.028
3501-2600	122.1	3	3	0.025	0.025
3601-3700	102.0	6	6	0.059	0.059
3701-3800	85.2	4	4	0.047	0.047
3801-3900	72.7	6	6	0.083	0.083
3901-4000	59.5	1	1	0.017	0.017
4001-4100	49.7	3	3	0.060	0.060

TABLE B60

Replacement Rates for Transmissions on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	705.0	0	0	0.000	0.000
101-200	705.0	0	0	0.000	0.000
201-300	705.0	1	1	0.001	0.001
301-400	705.0	0	0	0.000	0.000
401-500	705.0	2	2	0.003	0.003
501-600	705.0	4	4	0.006	0.006
601-700	705.0	2	2	0.003	0.003
701-800	704.1	1	1	0.001	0.001
801-900	701.3	0	0	0.000	0.000
901-1000	694.7	4	4	0.006	0.006
1001-1100	689.0	0	0	0.000	0.000
1101-1200	683.4	3	3	0.004	0.004
1201-1300	675.6	0	0	0.000	0.000
1301-1400	660.6	2	2	0.003	0.003
1401-1500	645.7	1	1	0.002	0.002
1501-1600	632.8	1	1	0.002	0.002
1601-1700	613.1	0	0	0.000	0.000
1701-1800	579.9	1	1	0.002	0.002
1801-1900	551.3	4	4	0.007	0.007
1901-2000	532.9	1	1	0.002	0.002
2001-2100	515.4	1	1	0.002	0.002
2101-2200	490.8	1	1	0.002	0.002
2201-2300	463.1	3	3	0.006	0.006
2301-2400	434.4	1	1	0.002	0.002
2401-2500	411.0	2	2	0.005	0.005
2501-2600	382.2	4	4	0.010	0.010
2601-2700	345.7	4	4	0.012	0.012
2701-2800	318.5	0	0	0.000	0.000
2801-2900	288.7	2	2	0.007	0.007
2901-3000	258.8	0	0	0.000	0.000
3001-3100	232.8	0	0	0.000	0.000
3101-3200	207.1	1	1	0.005	0.005
3201-3300	181.0	0	0	0.000	0.000
3301-3400	159.7	1	1	0.006	0.006
3401-3500	140.4	2	2	0.014	0.014
3501-3600	122.1	4	4	0.033	0.033
3601-3700	102.0	0	0	0.000	0.000
3701-3800	85.2	0	0	0.000	0.000
3801-3900	72.7	1	1	0.014	0.014
3901-4000	59.5	0	0	0.000	0.000
4001-4100	49.7	1	1	0.020	0.020

TABLE B61

Replacement Rates for Idler Wheels on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	2	3	0.004	0.006
201-300	466.0	3	3	0.006	0.006
301-400	466.5	5	8	0.011	0.017
401-500	469.2	5	10	0.011	0.021
501-600	475.8	14	18	0.029	0.038
601-700	488.3	3	3	0.006	0.006
701-800	501.1	28	51	0.056	0.102
801-900	507.1	11	24	0.022	0.047
901-1000	513.0	6	13	0.012	0.025
1001-1100	517.1	18	44	0.035	0.085
1101-1200	520.1	12	38	0.023	0.073
1201-1300	528.5	21	43	0.040	0.081
1301-1400	525.8	12	25	0.023	0.048
1401-1500	532.3	10	33	0.019	0.062
1501-1600	538.5	7	21	0.013	0.039
1601-1700	532.6	15	38	0.028	0.071
1701-1800	514.2	19	69	0.037	0.134
1801-1900	495.1	11	24	0.022	0.048
1901-2000	487.8	13	38	0.027	0.078
2001-2100	482.0	17	50	0.035	0.104
2101-2200	463.6	18	52	0.039	0.112
2201-2300	440.7	15	38	0.034	0.086
2301-2400	417.6	14	33	0.034	0.079
2401-2500	402.0	10	22	0.025	0.055
2501-2600	378.3	4	11	0.011	0.029
2601-2700	343.2	4	11	0.012	0.032
2701-2800	317.0	6	18	0.019	0.057
2801-2900	287.7	5	16	0.017	0.056
2901-3000	257.8	2	5	0.008	0.019
3001-3100	232.7	2	5	0.009	0.021
3101-3200	207.1	5	16	0.024	0.077
3201-3300	181.0	2	8	0.011	0.044
3301-3400	159.7	5	20	0.031	0.125
3401-3500	140.4	6	21	0.043	0.150
3501-3600	122.1	2	6	0.016	0.049
3601-3700	102.0	7	23	0.069	0.225
3701-3800	85.2	3	12	0.035	0.141
3801-3900	72.7	4	16	0.055	0.220
3901-4000	59.5	1	2	0.017	0.034
4001-4100	49.7	5	20	0.101	0.402
4101-4200	37.9	2	8	0.053	0.211
4201-4300	27.8	0	0	0.000	0.000
4301-4400	19.6	3	10	0.153	0.510
4401-4500	14.3	1	4	0.070	0.280

TABLE B62

Replacement Rates for Road Wheels on M113 APCs in USAREUR

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	466.0	0	0	0.000	0.000
101-200	466.0	0	0	0.000	0.000
201-300	466.0	0	0	0.000	0.000
301-400	466.5	1	1	0.002	0.002
401-500	469.2	2	5	0.004	0.011
501-600	475.8	1	1	0.002	0.002
601-700	488.3	0	0	0.000	0.000
701-800	501.1	1	5	0.002	0.010
801-900	507.1	1	2	0.002	0.004
901-1000	513.0	2	6	0.004	0.012
1001-1100	517.1	5	10	0.010	0.019
1101-1200	520.1	1	2	0.002	0.004
1201-1300	528.5	3	4	0.006	0.008
1301-1400	525.8	2	3	0.004	0.006
1401-1500	532.3	4	5	0.008	0.009
1501-1600	538.5	2	3	0.004	0.006
1601-1700	532.6	0	0	0.000	0.000
1701-1800	514.2	2	5	0.004	0.010
1801-1900	495.1	1	6	0.002	0.012
1901-2000	487.8	6	28	0.012	0.057
2001-2100	482.0	8	29	0.017	0.060
2101-2200	463.6	8	29	0.017	0.063
2201-2300	440.7	5	16	0.011	0.036
2301-2400	417.6	3	15	0.007	0.036
2401-2500	402.0	10	34	0.025	0.085
2501-2600	378.3	4	20	0.011	0.053
2601-2700	343.2	6	17	0.017	0.050
2701-2800	317.0	3	6	0.009	0.019
2801-2900	287.7	4	14	0.014	0.049
2901-3000	257.8	4	8	0.016	0.031
3001-3100	232.7	2	3	0.009	0.013
3101-3200	207.1	4	28	0.019	0.135
3201-3300	181.0	5	8	0.028	0.044
3301-3400	159.7	5	16	0.031	0.100
3401-3500	140.4	3	28	0.021	0.199
3501-3600	122.1	1	3	0.008	0.025
3601-3700	102.0	0	0	0.000	0.000
3701-3800	85.2	1	1	0.012	0.012
3801-3900	72.7	2	9	0.028	0.124
3901-4000	59.5	3	13	0.050	0.218
4001-4100	49.7	2	10	0.040	0.201
4101-4200	37.9	1	2	0.026	0.053
4201-4300	27.8	1	7	0.036	0.252
4301-4400	19.6	1	3	0.051	0.153
4401-4500	14.3	0	0	0.000	0.000
4501-4600	9.6	1	4	0.104	0.417

IN USAREUR, BASED ON MONTHS IN SERVICE

TABLE B63

Replacement Rates for Batteries on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	466.0	1	2	0.002	0.004
1-2	469.0	1	1	0.002	0.002
2-3	473.6	2	3	0.004	0.006
3-4	481.7	2	2	0.004	0.004
4-5	494.4	0	0	0.000	0.000
5-6	515.8	7	9	0.014	0.017
6-7	577.8	4	6	0.007	0.010
7-8	629.0	7	13	0.011	0.021
8-9	654.2	7	8	0.011	0.012
9-10	645.7	5	6	0.008	0.009
10-11	638.9	7	9	0.011	0.014
11-12	633.5	5	8	0.008	0.013
12-13	619.8	3	3	0.010	0.010
13-14	606.9	7	9	0.012	0.015
14-15	597.3	7	10	0.012	0.017
15-16	577.0	11	14	0.019	0.024
16-17	523.1	20	25	0.038	0.048
17-18	430.5	8	11	0.019	0.026
18-19	309.6	6	9	0.019	0.029
19-20	243.9	5	7	0.021	0.029
20-21	194.8	8	10	0.041	0.051
21-22	136.9	2	2	0.015	0.015
22-23	55.4	2	3	0.036	0.054
23-24	40.8	1	1	0.025	0.025

TABLE B64

Replacement Rates for Ignition Coils on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	4	4	0.009	0.009
2-3	473.6	3	3	0.006	0.006
3-4	481.7	4	4	0.010	0.010
4-5	494.4	1	1	0.002	0.002
5-6	515.8	9	9	0.017	0.017
6-7	577.8	12	12	0.021	0.021
7-8	629.0	4	4	0.006	0.006
8-9	654.2	3	3	0.005	0.005
9-10	645.7	8	8	0.012	0.012
10-11	638.9	5	5	0.008	0.008
11-12	633.5	9	9	0.014	0.014
12-13	619.8	1	1	0.002	0.002
13-14	606.9	8	8	0.013	0.013
14-15	597.3	7	7	0.012	0.012
15-16	577.0	3	3	0.005	0.005
16-17	523.1	4	4	0.008	0.008
17-18	430.5	6	6	0.014	0.014
18-19	309.6	5	5	0.016	0.016
19-20	243.9	1	1	0.004	0.004
20-21	194.8	4	4	0.021	0.021
21-22	136.9	1	1	0.007	0.007

TABLE B65

Replacement Rates for Differentials on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	2	2	0.004	0.004
2-3	473.6	3	3	0.006	0.006
3-4	481.7	1	1	0.002	0.002
4-5	494.4	1	1	0.002	0.002
5-6	515.8	7	7	0.014	0.014
6-7	577.8	10	10	0.017	0.017
7-8	629.0	5	5	0.008	0.008
8-9	654.2	2	2	0.003	0.003
9-10	645.7	3	3	0.005	0.005
10-11	638.9	3	3	0.005	0.005
11-12	633.5	4	4	0.006	0.006
12-13	619.8	2	2	0.003	0.003
13-14	606.9	2	2	0.003	0.003
14-15	597.3	4	4	0.007	0.007
15-16	577.0	1	1	0.002	0.002
16-17	523.1	1	1	0.002	0.002
17-18	430.5	1	1	0.002	0.002
18-19	309.6	1	1	0.003	0.003

TABLE B66

Replacement Rates for Distributors on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	0	0	0.000	0.000
2-3	473.6	0	0	0.000	0.000
3-4	481.7	2	2	0.004	0.004
4-5	494.4	4	4	0.008	0.008
5-6	515.8	1	1	0.002	0.002
6-7	577.8	6	6	0.010	0.010
7-8	629.0	4	4	0.006	0.006
8-9	654.2	5	5	0.008	0.008
9-10	645.7	4	4	0.006	0.006
10-11	638.9	3	3	0.005	0.005
11-12	633.5	9	9	0.014	0.014
12-13	619.8	13	13	0.021	0.021
13-14	606.9	6	6	0.010	0.010
14-15	597.3	15	15	0.025	0.025
15-16	577.0	15	15	0.026	0.026
16-17	523.1	5	5	0.010	0.010
17-18	430.5	6	6	0.014	0.014
18-19	309.6	4	4	0.013	0.013
19-20	243.9	8	8	0.033	0.033
20-21	194.8	4	4	0.021	0.021

TABLE B67

Replacement Rates for Engines on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	705.0	0	0	0.000	0.000
1-2	704.7	0	0	0.000	0.000
2-3	703.0	3	3	0.004	0.004
3-4	703.0	2	2	0.003	0.003
4-5	703.0	1	1	0.001	0.001
5-6	702.2	2	2	0.003	0.003
6-7	699.9	2	2	0.003	0.003
7-8	694.1	4	4	0.006	0.006
8-9	684.5	7	7	0.010	0.010
9-10	675.0	2	2	0.003	0.003
10-11	654.6	3	3	0.005	0.005
11-12	644.5	4	4	0.006	0.006
12-13	627.9	9	9	0.014	0.014
13-14	612.0	4	4	0.007	0.007
14-15	600.3	9	9	0.015	0.015
15-16	580.0	11	11	0.019	0.019
16-17	525.7	9	9	0.017	0.017
17-18	432.5	4	4	0.009	0.009
18-19	311.6	5	5	0.016	0.016
19-20	245.9	2	2	0.008	0.008
20-21	196.8	2	2	0.010	0.010
21-22	138.9	9	9	0.065	0.065
22-23	57.4	2	2	0.035	0.035
23-24	42.0	1	1	0.024	0.024
24-25	32.8	1	1	0.030	0.030

TABLE B68

Replacement Rates for Track Pads on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	1	1	0.002	0.002
1-2	469.0	1	126	0.002	0.269
2-3	473.6	5	8	0.011	0.017
3-4	481.7	3	6	0.006	0.012
4-5	494.4	9	146	0.018	0.295
5-6	515.8	4	5	0.008	0.010
6-7	577.8	6	259	0.010	0.448
7-8	629.0	11	665	0.017	1.057
8-9	654.2	20	2488	0.031	3.803
9-10	645.7	10	537	0.015	0.832
10-11	638.9	24	1988	0.038	3.112
11-12	633.5	48	4978	0.076	7.858
12-13	619.8	44	9951	0.071	16.055
13-14	606.9	37	7883	0.061	12.989
14-15	597.3	32	10604	0.054	17.753
15-16	577.0	33	5438	0.057	9.425
16-17	523.1	31	11573	0.059	22.124
17-18	430.5	20	5030	0.046	11.684
18-19	309.6	15	482	0.048	1.557
19-20	243.9	9	1018	0.037	4.174
20-21	194.8	9	1023	0.046	5.252
21-22	136.9	9	576	0.066	4.207
22-23	55.4	1	127	0.018	2.292

TABLE B69

Replacement Rates for Radiators on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	1	1	0.002	0.002
2-3	473.6	2	2	0.004	0.004
3-4	481.7	1	1	0.002	0.002
4-5	494.4	1	1	0.002	0.002
5-6	515.8	1	1	0.002	0.002
6-7	577.8	2	2	0.003	0.003
7-8	629.0	2	2	0.003	0.003
8-9	654.2	1	1	0.002	0.002
9-10	645.7	2	2	0.003	0.003
10-11	638.9	4	4	0.006	0.006
11-12	633.5	3	3	0.005	0.005
12-13	619.8	5	5	0.008	0.008
13-14	606.9	8	8	0.013	0.013
14-15	597.3	11	11	0.018	0.018
15-16	577.0	3	3	0.005	0.005
16-17	523.1	4	4	0.008	0.008
17-18	430.5	6	6	0.014	0.014
18-19	3[illegible].6	1	1	0.003	0.003
19-20	243.9	1	1	0.004	0.004
20-21	194.8	4	4	0.021	0.021
21-22	136.9	0	0	0.000	0.000
22-23	55.4	1	1	0.018	0.018
23-24	40.8	1	1	0.025	0.025

TABLE B70

Replacement Rates for Road Wheel Hub Seals on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	2	2	0.004	0.004
2-3	473.6	2	2	0.004	0.004
3-4	481.7	3	3	0.006	0.006
4-5	494.4	2	2	0.004	0.004
5-6	515.8	3	6	0.006	0.012
6-7	577.8	4	5	0.007	0.009
7-8	629.0	4	4	0.006	0.006
8-9	654.2	5	6	0.008	0.009
9-10	645.7	4	4	0.006	0.006
10-11	638.9	1	1	0.002	0.002
11-12	633.5	3	6	0.005	0.009
12-13	619.8	6	7	0.010	0.011
13-14	606.9	1	1	0.002	0.002
14-15	597.3	5	9	0.008	0.015
15-16	577.0	3	4	0.005	0.007
16-17	523.1	9	11	0.017	0.021
17-18	430.5	6	13	0.014	0.030
18-19	309.6	3	5	0.010	0.016
19-20	243.9	5	7	0.021	0.029
20-21	194.8	0	0	0.000	0.000
21-22	136.9	2	4	0.015	0.029
22-23	55.4	1	1	0.018	0.018

TABLE B71

Replacement Rates for Shock Absorbers on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	1	1	0.002	0.002
1-2	469.0	0	0	0.000	0.000
2-3	473.6	2	2	0.004	0.004
3-4	481.7	1	1	0.002	0.002
4-5	494.4	0	0	0.000	0.000
5-6	515.8	1	1	0.002	0.002
6-7	577.8	1	1	0.002	0.002
7-8	629.0	3	3	0.005	0.005
8-9	654.2	3	3	0.005	0.005
9-10	645.7	6	6	0.009	0.009
10-11	638.9	5	10	0.008	0.016
11-12	633.5	8	9	0.013	0.014
12-13	619.8	11	19	0.018	0.031
13-14	606.9	10	13	0.016	0.021
14-15	597.3	10	15	0.017	0.025
15-16	577.0	12	17	0.021	0.029
16-17	523.1	13	19	0.025	0.036
17-18	430.5	17	24	0.039	0.056
18-19	309.6	9	19	0.029	0.061
19-20	243.9	14	21	0.057	0.086
20-21	194.8	9	13	0.046	0.067
21-22	136.9	1	1	0.007	0.007

TABLE B72

Replacement Rates for Track Shoes on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	467.0	1	6	0.002	0.013
1-2	470.0	3	6	0.006	0.013
2-3	474.6	8	138	0.017	0.291
3-4	482.7	5	6	0.010	0.012
4-5	495.4	11	154	0.022	0.311
5-6	516.8	12	111	0.023	0.215
6-7	578.8	17	156	0.029	0.270
7-8	630.0	12	804	0.019	1.276
8-9	655.2	22	1230	0.034	1.877
9-10	646.7	11	405	0.017	0.626
10-11	639.9	11	37	0.017	0.058
11-12	634.5	13	197	0.020	0.310
12-13	620.8	24	508	0.039	0.818
13-14	607.9	28	5615	0.046	9.237
14-15	598.3	19	5127	0.032	8.569
15-16	578.0	44	9363	0.076	15.634
16-17	524.1	25	3621	0.048	6.909
17-18	431.5	25	3667	0.058	8.498
18-19	310.6	10	383	0.032	1.233
19-20	244.9	10	534	0.041	2.180
20-21	195.8	13	1094	0.066	5.587
21-22	137.0	7	635	0.051	4.635
22-23	55.4	1	127	0.018	2.292

TABLE B73

Replacement Rates for Spark Plugs on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	466.0	4	12	0.009	0.026
1-2	469.0	8	53	0.017	0.113
2-3	473.6	11	64	0.023	0.135
3-4	481.7	16	82	0.033	0.170
4-5	494.4	17	106	0.034	0.214
5-6	515.8	13	69	0.025	0.134
6-7	577.8	19	141	0.033	0.244
7-8	629.0	18	102	0.029	0.162
8-9	654.2	18	79	0.028	0.121
9-10	645.7	23	107	0.036	0.166
10-11	638.9	16	137	0.025	0.214
11-12	633.5	21	118	0.033	0.186
12-13	619.8	20	132	0.032	0.213
13-14	606.9	26	170	0.043	0.280
14-15	597.3	17	111	0.028	0.186
15-16	577.0	25	171	0.043	0.296
16-17	523.1	20	143	0.038	0.273
17-18	430.5	18	122	0.042	0.283
18-19	309.6	15	98	0.048	0.317
19-20	243.9	9	48	0.037	0.197
20-21	194.8	9	51	0.046	0.262
21-22	136.9	5	40	0.037	[illegible]
22-23	55.4	2	7	0.036	0.126
23-24	40.8	3	20	0.074	0.490
24-25	31.8	1	8	0.031	0.252

TABLE B74

Replacement Rates for Sprockets on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-1	466.0	0	0	0.000	0.000
1-2	469.0	0	0	0.000	0.000
2-3	473.6	0	0	0.000	0.000
3-4	481.7	0	0	0.000	0.000
4-5	494.4	1	2	0.002	0.004
5-6	515.8	0	0	0.000	0.000
6-7	577.8	1	2	0.002	0.003
7-8	629.0	2	6	0.003	0.010
8-9	654.2	5	17	0.008	0.026
9-10	645.7	2	8	0.003	0.012
10-11	638.9	3	7	0.005	0.011
11-12	633.5	3	10	0.005	0.016
12-13	619.8	6	21	0.010	0.034
13-14	606.9	12	39	0.020	0.064
14-15	597.3	8	20	0.013	0.033
15-16	577.0	17	49	0.029	0.085
16-17	523.1	3	10	0.006	0.019
17-18	430.5	11	33	0.026	0.077
18-19	309.6	7	13	0.023	0.042
19-20	243.9	12	27	0.049	0.111
20-21	194.8	14	26	0.072	0.133
21-22	136.9	4	14	0.029	0.102
22-23	55.4	2	8	0.036	0.144
23-24	40.8	1	4	0.025	0.096

TABLE B75

Replacement Rates for Starters on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	466.0	7	7	0.015	0.015
1-2	469.0	11	11	0.023	0.023
2-3	473.6	8	8	0.017	0.017
3-4	481.7	9	9	0.019	0.019
4-5	494.4	11	11	0.022	0.022
5-6	515.8	19	19	0.037	0.037
6-7	577.8	12	12	0.021	0.021
7-8	629.0	19	19	0.030	0.030
8-9	654.2	8	8	0.012	0.012
9-10	645.7	14	14	0.022	0.022
10-11	638.9	13	13	0.020	0.020
11-12	633.5	20	20	0.032	0.032
12-13	619.8	19	19	0.031	0.031
13-14	606.9	13	13	0.021	0.021
14-15	597.3	20	20	0.033	0.033
15-16	577.0	19	19	0.033	0.033
16-17	523.1	16	16	0.031	0.031
17-18	430.5	11	11	0.026	0.026
18-19	309.6	8	8	0.026	0.026
19-20	243.9	13	13	0.053	0.053
20-21	194.8	19	19	0.098	0.098
21-22	136.9	3	3	0.022	0.022

TABLE B76

Replacement Rates for Transmissions on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-1	705.0	0	0	0.000	0.000
1-2	704.7	1	1	0.001	0.001
2-3	703.0	1	1	0.001	0.001
3-4	703.0	3	3	0.004	0.004
4-5	703.0	2	2	0.003	0.003
5-6	702.2	3	3	0.004	0.004
6-7	699.9	3	3	0.004	0.004
7-8	694.1	0	0	0.000	0.000
8-9	684.5	3	3	0.004	0.004
9-10	675.0	2	2	0.003	0.003
10-11	654.6	2	2	0.003	0.003
11-12	644.5	4	4	0.006	0.006
12-13	627.9	5	5	0.008	0.008
13-14	612.0	1	1	0.002	0.002
14-15	600.3	4	4	0.007	0.007
15-16	580.0	8	8	0.014	0.014
16-17	525.7	5	5	0.010	0.010
17-18	432.5	1	1	0.002	0.002
18-19	311.6	3	3	0.010	0.010
19-20	245.9	1	1	0.004	0.004
20-21	196.8	0	0	0.000	0.000
21-22	138.9	1	1	0.007	0.007
22-23	57.4	0	0	0.000	0.000
23-24	42.0	2	2	0.048	0.048

TABLE B77

Replacement Rates for Idler Wheels on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-1	466.0	4	6	0.009	0.013
1-2	469.0	20	28	0.043	0.060
2-3	473.6	16	31	0.034	0.065
3-4	481.7	32	62	0.066	0.129
4-5	494.4	13	34	0.026	0.069
5-6	515.8	22	51	0.043	0.099
6-7	577.8	28	50	0.048	0.087
7-8	629.0	19	63	0.030	0.100
8-9	654.2	14	34	0.021	0.052
9-10	645.7	42	109	0.065	0.169
10-11	638.9	27	68	0.042	0.106
11-12	633.5	23	65	0.036	0.103
12-13	619.8	7	12	0.011	0.019
13-14	606.9	11	31	0.018	0.051
14-15	597.3	19	61	0.032	0.102
15-16	577.0	9	30	0.016	0.052
16-17	523.1	9	20	0.017	0.038
17-18	430.5	19	64	0.044	0.149
18-19	309.6	11	34	0.036	0.110
19-20	243.9	6	17	0.025	0.070
20-21	194.8	13	45	0.067	0.231
21-22	136.9	10	38	0.073	0.278
22-23	55.4	1	4	0.018	0.072

TABLE B78

Replacement Rates for Road Wheels on M113 APCs in USAREUR

Usage interval, months	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{e/e}$ replacement rate for: Maintenance actions	Parts replaced
0-1	466.0	1	1	0.002	0.002
1-2	469.0	2	3	0.004	0.006
2-3	473.6	1	1	0.002	0.002
3-4	481.7	1	2	0.002	0.004
4-5	494.4	4	11	0.008	0.022
5-6	515.8	3	5	0.006	0.010
6-7	577.8	6	7	0.010	0.012
7-8	629.0	3	26	0.005	0.041
8-9	654.2	2	3	0.003	0.005
9-10	645.7	11	34	0.017	0.053
10-11	638.9	8	29	0.013	0.045
11-12	633.5	8	23	0.013	0.036
12-13	619.8	6	8	0.010	0.013
13-14	606.9	8	29	0.013	0.048
14-15	597.3	8	16	0.013	0.027
15-16	577.0	7	30	0.012	0.052
16-17	523.1	8	33	0.015	0.063
17-18	430.5	12	39	0.028	0.091
18-19	309.6	12	28	0.039	0.090
19-20	243.9	5	43	0.021	0.176
20-21	194.8	4	15	0.021	0.077
21-22	136.9	3	25	0.022	0.183

IN 24th INF (MECH) DIV, BASED ON MILES OF OPERATION

TABLE B79

Replacement Rates for Batteries on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	0	0	0.000	0.000
601-700	160.8	1	1	0.006	0.006
701-800	165.0	0	0	0.000	0.000
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	0	0	0.000	0.000
1101-1200	183.7	0	0	0.000	0.000
1201-1300	196.9	1	1	0.005	0.005
1301-1400	207.0	0	0	0.000	0.000
1401-1500	225.1	0	0	0.000	0.000
1501-1600	241.5	0	0	0.000	0.000
1601-1700	251.7	2	2	0.008	0.008
1701-1800	260.4	1	1	0.004	0.004
1801-1900	263.6	0	0	0.000	0.000
1901-2000	267.6	2	2	0.007	0.007
2001-2100	271.4	0	0	0.000	0.000
2101-2200	266.6	1	1	0.004	0.004
2201-2300	258.1	3	5	0.012	0.019
2301-2400	246.9	0	0	0.000	0.000
2401-2500	242.7	3	6	0.012	0.025
2501-2600	230.8	3	3	0.013	0.013
2601-2700	210.1	2	2	0.010	0.010
2701-2800	193.1	1	2	0.005	0.010
2801-2900	178.7	0	0	0.000	0.000
2901-3000	160.1	1	2	0.006	0.012
3001-3100	148.6	1	1	0.007	0.007
3101-3200	136.2	1	1	0.007	0.007
3201-3300	119.7	1	2	0.008	0.017
3301-3400	106.1	3	5	0.028	0.047
3401-3500	92.9	3	3	0.032	0.032
3501-3600	81.3	4	6	0.049	0.074
3601-3700	71.6	1	2	0.014	0.028
3701-3800	64.6	4	6	0.062	0.093
3801-3900	55.4	1	1	0.018	0.018
3901-4000	45.0	0	0	0.000	0.000
4001-4100	36.7	2	2	0.054	0.054

TABLE B79 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	152.7	0	0	0.000	0.000
501-1000	164.7	1	1	0.006	0.006
1001-1500	198.3	1	1	0.005	0.005
1501-2000	257.0	5	5	0.019	0.019
2001-2500	257.1	7	12	0.027	0.047
2501-3000	194.6	7	9	0.036	0.046
3001-3500	120.7	9	12	0.075	0.099
3501-4000	63.6	10	15	0.157	0.236

TABLE B80

Replacement Rates for Distributors on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	0	0	0.000	0.000
601-700	160.8	1	1	0.006	0.006
701-800	165.0	0	0	0.000	0.000
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	0	0	0.000	0.000
1101-1200	183.7	0	0	0.000	0.000
1201-1300	196.9	1	1	0.005	0.005
1301-1400	207.0	0	0	0.000	0.000
1401-1500	225.1	3	3	0.013	0.013
1501-1600	241.5	1	1	0.004	0.004
1601-1700	251.7	0	0	0.000	0.000
1701-1800	260.4	2	2	0.008	0.008
1801-1900	263.6	1	1	0.004	0.004
1901-2000	267.6	1	1	0.004	0.004
2001-2100	271.4	2	2	0.007	0.007
2101-2200	266.6	5	5	0.019	0.019
2201-2300	258.1	2	2	0.008	0.008
2301-2400	246.9	1	1	0.004	0.004
2401-2500	242.7	0	0	0.000	0.000
2501-2600	230.8	2	2	0.009	0.009
2601-2700	210.1	1	1	0.005	0.005
2701-2800	193.1	1	1	0.005	0.005
2801-2900	178.7	2	2	0.006	0.006
2901-3000	160.1	1	1	0.006	0.006
3001-3100	148.6	1	1	0.007	0.007
3101-3200	136.2	2	2	0.015	0.015
3201-3300	119.7	1	1	0.008	0.008
3301-3400	106.1	0	0	0.000	0.000
3401-3500	92.9	2	2	0.022	0.022
3501-3600	81.3	1	1	0.012	0.012
3601-3700	71.6	1	1	0.014	0.014
3701-3800	64.6	1	1	0.015	0.015
3801-3900	55.4	0	0	0.000	0.000
3901-4000	45.0	1	1	0.022	0.022
4001-4100	36.7	2	2	0.054	0.054
4101-4200	27.8	1	1	0.036	0.036
4201-4300	20.2	1	1	0.050	0.050

TABLE B80 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	0	0	0.000	0.000
501-1000	164.7	1	1	0.006	0.006
1001-1500	198.3	4	4	0.020	0.020
1501-2000	257.0	5	5	0.019	0.019
2001-2500	257.1	10	10	0.039	0.039
2501-3000	194.6	7	7	0.036	0.036
3001-3500	120.7	6	6	0.050	0.050
3501-4000	63.6	4	4	0.063	0.063

TABLE B81

Replacement Rates for Engines on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	346.0	0	0	0.000	0.000
101-200	346.0	1	1	0.003	0.003
201-300	346.0	1	1	0.003	0.003
301-400	346.0	1	1	0.003	0.003
401-500	346.0	0	0	0.000	0.000
501-600	346.0	0	0	0.000	0.000
601-700	346.0	1	1	0.003	0.003
701-800	346.0	0	0	0.000	0.000
801-900	346.0	2	2	0.006	0.006
901-1000	345.1	1	1	0.003	0.003
1001-1100	343.5	0	0	0.000	0.000
1101-1200	341.4	1	1	0.003	0.003
1201-1300	340.0	0	0	0.000	0.000
1301-1400	338.5	0	0	0.000	0.000
1401-1500	336.4	2	2	0.006	0.006
1501-1600	332.9	2	2	0.006	0.006
1601-1700	329.7	2	2	0.006	0.006
1701-1800	325.0	2	2	0.006	0.006
1801-1900	318.8	3	3	0.009	0.009
1901-2000	311.7	2	2	0.006	0.006
2001-2100	303.8	1	1	0.003	0.003
2101-2200	294.2	1	1	0.003	0.003
2201-2300	281.5	1	1	0.004	0.004
2301-2400	263.7	1	1	0.004	0.004
2401-2500	251.7	4	4	0.016	0.016
2501-2600	234.7	1	1	0.004	0.004
2601-2700	212.6	3	3	0.014	0.014
2701-2800	194.6	0	0	0.000	0.000
2801-2900	179.7	2	2	0.011	0.011
2901-3000	161.1	4	4	0.025	0.025
3001-3100	148.8	2	2	0.013	0.013
3101-3200	136.2	1	1	0.007	0.007
3201-3300	119.7	0	0	0.000	0.000
3301-3400	106.1	0	0	0.000	0.000
3401-3500	92.9	2	2	0.022	0.022
3501-3600	81.3	3	3	0.037	0.037
3601-3700	71.6	2	2	0.028	0.028
3701-3800	64.6	0	0	0.000	0.000
3801-3900	55.4	1	1	0.018	0.018
3901-4000	45.0	1	1	0.022	0.022

TABLE B81 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Mainte-nance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-500	346.0	3	3	0.009	0.009
501-1000	345.8	4	4	0.012	0.012
1001-1500	340.0	3	3	0.009	0.009
1501-2000	323.6	11	11	0.034	0.034
2001-2500	279.0	8	8	0.029	0.029
2501-3000	196.5	10	10	0.051	0.051
3001-3500	120.7	5	5	0.041	0.041
3501-4000	63.6	7	7	0.110	0.110

TABLE B82

Replacement Rates for Track Pads on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/e}$ replacement rate for: Maintenance actions	$R_{a/e}$ replacement rate for: Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	1	127	0.006	0.810
601-700	160.8	0	0	0.000	0.000
701-800	165.0	2	3	0.012	0.018
801-900	167.6	1	127	0.006	0.758
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	2	128	0.011	0.715
1101-1200	183.7	6	637	0.033	3.468
1201-1300	196.9	3	131	0.015	0.665
1301-1400	207.0	5	258	0.024	1.246
1401-1500	225.1	3	255	0.013	1.133
1501-1600	241.5	6	636	0.025	2.634
1601-1700	251.7	7	764	0.028	3.035
1701-1800	260.4	6	636	0.023	2.442
1801-1900	263.6	5	635	0.019	2.409
1901-2000	267.6	13	1526	0.049	5.703
2001-2100	271.4	12	1524	0.044	5.615
2101-2200	266.6	15	1905	0.056	7.146
2201-2300	258.1	14	1778	0.054	6.889
2301-2400	246.9	7	764	0.028	3.094
2401-2500	242.7	16	1855	0.066	7.643
2501-2600	230.8	9	929	0.039	4.025
2601-2700	210.1	8	892	0.038	4.246
2701-2800	193.1	10	1268	0.052	6.567
2801-2900	178.7	13	1400	0.073	7.834
2901-3000	160.1	7	576	0.044	3.598
3001-3100	148.6	6	512	0.040	3.445
3101-3200	136.2	4	508	0.029	3.730
3201-3300	119.7	9	824	0.075	6.884
3301-3400	106.1	5	633	0.047	5.966
3401-3500	92.9	8	783	0.086	8.428
3501-3600	81.3	12	1309	0.148	16.101
3601-3700	71.6	10	1206	0.140	16.844
3701-3800	64.6	5	571	0.077	8.839
3801-3900	55.4	3	256	0.054	4.621
3901-4000	45.0	0	0	0.000	0.000
4001-4100	46.7	4	382	0.109	10.409
4101-4200	27.8	0	0	0.000	0.000
4201-4300	20.2	1	62	0.050	3.069
4301-4400	12.6	3	381	0.238	30.238

TABLE B82 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	152.7	0	0	0.000	0.000
501-1000	164.7	4	254	0.024	1.542
1001-1500	198.3	19	1409	0.096	7.105
1501-2000	257.0	37	4197	0.144	16.331
2001-2500	257.1	64	7826	0.249	30.440
2501-3000	194.6	47	5065	0.242	26.028
3001-3500	120.7	32	3260	0.265	27.009
2501-4000	63.6	30	3342	0.472	52.547

TABLE B83

Replacement Rates for Road Wheel Hub Seals on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	1	1	0.007	0.007
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	0	0	0.000	0.000
601-700	160.8	2	2	0.012	0.012
701-800	165.0	1	1	0.006	0.006
801-900	167.6	1	1	0.006	0.006
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	2	5	0.011	0.028
1101-1200	183.7	2	3	0.011	0.016
1201-1300	196.9	2	3	0.010	0.015
1301-1400	207.0	1	1	0.005	0.005
1401-1500	225.1	0	0	0.000	0.000
1501-1600	241.5	0	0	0.000	0.000
1601-1700	251.7	1	1	0.004	0.004
1701-1800	260.4	1	1	0.004	0.004
1801-1900	263.6	0	0	0.000	0.000
1901-2000	267.6	0	0	0.000	0.000
2001-2100	271.4	4	9	0.015	0.033
2101-2200	266.6	3	3	0.011	0.011
2201-2300	258.1	1	3	0.004	0.012
2301-2400	246.9	3	3	0.012	0.012
2401-2500	242.7	1	1	0.004	0.004
2501-2600	230.8	1	1	0.004	0.004
2601-2700	210.1	2	2	0.010	0.010
2701-2800	193.1	0	0	0.000	0.000
2801-2900	178.7	1	1	0.006	0.006
2901-3000	160.1	2	3	0.012	0.019
3001-3100	148.6	1	8	0.007	0.054
3101-3200	136.2	0	0	0.000	0.000
3201-3300	119.7	1	1	0.008	0.008
3301-3400	106.1	0	0	0.000	0.000
3401-3500	92.9	1	1	0.011	0.011
3501-3600	81.3	0	0	0.000	0.000
3601-3700	71.6	4	4	0.056	0.056
3701-3800	64.6	0	0	0.000	0.000
3801-3900	55.4	0	0	0.000	0.000
3901-4000	45.0	3	5	0.067	0.111
4001-4100	36.7	1	2	0.027	0.054

TABLE B83 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	Parts replaced
0-500	152.7	1	1	0.007	0.007
501-1000	164.7	4	4	0.024	0.024
1001-1500	198.3	7	12	0.035	0.061
1501-2000	257.0	2	2	0.008	0.008
2001-2500	257.1	12	19	0.047	0.074
2501-3000	194.6	6	7	0.031	0.036
3001-3500	120.7	3	10	0.025	0.083
3501-4000	63.6	7	9	0.110	0.142

TABLE B84

Replacement Rates for Shock Absorbers on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/a}$ replacement rate for: Maintenance actions	$R_{a/a}$ replacement rate for: Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	0	0	0.000	0.000
601-700	160.8	2	2	0.012	0.012
701-800	165.0	0	0	0.000	0.000
801-900	167.6	1	1	0.006	0.006
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	0	0	0.000	0.000
1101-1200	183.7	0	0	0.000	0.000
1201-1300	196.9	1	1	0.005	0.005
1301-1400	207.0	0	0	0.000	0.000
1401-1500	225.1	0	0	0.000	0.000
1501-1600	241.5	0	0	0.000	0.000
1601-1700	251.7	2	2	0.008	0.008
1701-1800	260.4	2	2	0.008	0.008
1801-1900	263.6	1	1	0.004	0.004
1901-2000	267.6	0	0	0.000	0.000
2001-2100	271.4	0	0	0.000	0.000
2101-2200	266.6	3	4	0.011	0.015
2201-2300	258.1	2	6	0.008	0.023
2301-2400	246.9	3	4	0.012	0.016
2401-2500	242.7	1	1	0.004	0.004
2501-2600	230.8	3	3	0.013	0.013
2601-2700	210.1	0	0	0.000	0.000
2701-2800	193.1	1	1	0.005	0.005
2801-2900	178.7	0	0	0.000	0.000
2901-3000	160.1	2	3	0.012	0.019
3001-3100	148.6	2	3	0.013	0.020
3101-3200	136.2	0	0	0.000	0.000
3201-3300	119.7	2	5	0.017	0.042
3301-3400	106.1	0	0	0.000	0.000
3401-3500	92.9	1	1	0.011	0.011
3501-3600	81.3	0	0	0.000	0.000
3601-3700	71.6	3	7	0.042	0.098
3701-3800	64.6	1	4	0.015	0.062
3801-3900	55.4	6	10	0.108	0.181
3901-4000	45.0	0	0	0.000	0.000
4001-4100	36.7	2	6	0.054	0.163
4101-4200	27.8	1	4	0.036	0.144
4201-4300	20.2	1	4	0.050	0.198

TABLE B84 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	0	0	0.000	0.000
501-1000	164.7	3	3	0.018	0.018
1001-1500	198.3	1	1	0.005	0.005
1501-2000	257.0	5	5	0.019	0.019
2001-2500	257.1	9	15	0.035	0.058
2501-3000	194.6	6	7	0.031	0.036
3001-3500	120.7	5	9	0.041	0.075
3501-4000	63.6	10	21	0.157	0.330

TABLE B85

Replacement Rates for Track Shoes on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	1	1	0.007	0.007
401-500	155.2	0	0	0.000	0.000
501-600	156.7	1	3	0.006	0.019
601-700	160.8	1	64	0.006	0.398
701-800	165.0	4	4	0.024	0.024
801-900	167.6	3	3	0.018	0.018
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	2	7	0.011	0.039
1101-1200	183.7	2	3	0.011	0.016
1201-1300	196.9	9	11	0.046	0.056
1301-1400	207.0	3	148	0.014	0.715
1401-1500	225.1	3	5	0.013	0.022
1501-1600	241.5	1	8	0.004	0.033
1601-1700	251.7	3	3	0.012	0.012
1701-1800	260.4	1	14	0.004	0.054
1801-1900	263.6	4	319	0.015	1.210
1901-2000	267.6	6	647	0.022	2.418
2001-2100	271.4	5	510	0.018	1.879
2101-2200	266.6	7	514	0.026	1.928
2201-2300	258.1	3	381	0.012	1.476
2301-2400	246.9	4	258	0.016	1.045
2401-2500	242.7	5	389	0.021	1.603
2501-2600	230.8	5	386	0.022	1.672
2601-2700	210.1	7	404	0.033	1.923
2701-2800	193.1	9	1019	0.047	5.277
2801-2900	178.7	8	951	0.045	5.322
2901-3000	160.1	8	386	0.050	2.411
3001-3100	148.6	8	464	0.054	3.122
3101-3200	136.2	7	550	0.051	4.038
3201-3300	119.7	8	706	0.067	5.898
3301-3400	106.1	10	658	0.094	6.202
3401-3500	92.9	9	725	0.097	7.804
3501-3600	81.3	15	1452	0.185	17.860
3601-3700	71.6	11	1186	0.154	16.564
3701-3800	64.6	6	515	0.093	7.972
3801-3900	55.4	5	582	0.090	10.505
3901-4000	45.0	2	31	0.044	0.689
4001-4100	36.7	5	445	0.136	12.125

TABLE B85 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	152.7	1	1	0.007	0.007
501-1000	164.7	9	74	0.055	0.449
1001-1500	198.3	19	174	0.096	0.877
1501-2000	257.0	15	991	0.058	3.856
2001-2500	257.1	24	2052	0.093	7.981
2501-3000	194.6	37	3146	0.190	16.166
3001-3500	120.7	42	3103	0.348	25.708
3501-4000	63.6	39	3766	0.613	59.214

TABLE B86

Replacement Rates for Spark Plugs on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	152.0	1	1	0.007	0.007
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	1	8	0.007	0.052
401-500	155.2	0	0	0.000	0.000
501-600	156.7	0	0	0.000	0.000
601-700	160.8	1	8	0.006	0.050
701-800	165.0	0	0	0.000	0.000
801-900	167.6	1	6	0.006	0.036
901-1000	173.5	1	6	0.006	0.035
1001-1100	178.9	0	0	0.000	0.000
1101-1200	183.7	1	8	0.005	0.044
1201-1300	196.9	7	56	0.036	0.284
1301-1400	207.0	3	10	0.014	0.048
1401-1500	225.1	2	9	0.009	0.040
1501-1600	241.5	3	24	0.012	0.099
1601-1700	251.7	3	17	0.012	0.068
1701-1800	260.4	3	24	0.012	0.092
1801-1900	263.6	7	56	0.027	0.212
1901-2000	267.6	4	32	0.015	0.120
2001-2100	271.4	3	19	0.011	0.070
2101-2200	266.6	9	60	0.034	0.225
2201-2300	258.1	3	14	0.012	0.054
2301-2400	246.9	8	57	0.032	0.231
2401-2500	242.7	2	13	0.008	0.054
2501-2600	230.8	4	32	0.017	0.139
2601-2700	210.1	6	48	0.029	0.228
2701-2800	193.1	2	9	0.010	0.047
2801-2900	178.7	2	16	0.011	0.090
2901-3000	160.1	2	16	0.012	0.100
3001-3100	148.6	6	39	0.040	0.262
3101-3200	136.2	6	44	0.044	0.323
3201-3300	119.7	1	8	0.008	0.067
3301-3400	106.1	3	24	0.028	0.226
3401-3500	92.9	3	24	0.032	0.258
3501-3600	81.3	6	32	0.074	0.394
3601-3700	71.6	0	0	0.000	0.000
3701-3800	64.6	2	16	0.031	0.248
3801-3900	55.4	3	24	0.054	0.433
3901-4000	45.0	3	13	0.067	0.289
4001-4100	36.7	6	42	0.163	1.144
4101-4200	27.8	1	4	0.036	0.144
4201-4300	20.2	2	8	0.099	0.396

TABLE B86 (continued)

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-500	152.7	2	9	0.013	0.059
501-1000	164.7	3	20	0.018	0.121
1001-1500	198.3	13	83	0.066	0.419
1501-2000	257.0	20	153	0.078	0.595
2001-2500	257.1	25	163	0.097	0.634
2501-3000	194.6	16	121	0.082	0.622
3001-3500	120.7	19	139	0.157	1.152
3501-4000	63.6	14	85	0.220	1.336

TABLE B87

Replacement Rates for Sprockets on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/a}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	0	0	0.000	0.000
401-500	155.2	0	0	0.000	0.000
501-600	156.7	1	4	0.006	0.026
601-700	160.8	0	0	0.000	0.000
701-800	165.0	0	0	0.000	0.000
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	0	0	0.000	0.000
1101-1200	183.7	0	0	0.000	0.000
1201-1300	196.9	0	0	0.000	0.000
1301-1400	207.0	1	4	0.005	0.019
1401-1500	225.1	0	0	0.000	0.000
1501-1600	241.5	0	0	0.000	0.000
1601-1700	251.7	0	0	0.000	0.000
1701-1800	260.4	1	1	0.004	0.004
1801-1900	263.6	0	0	0.000	0.000
1901-2000	267.6	1	1	0.004	0.004
2001-2100	271.4	0	0	0.000	0.000
2101-2200	266.6	1	4	0.004	0.015
2201-2300	258.1	2	6	0.008	0.023
2301-2400	246.9	2	8	0.008	0.032
2401-2500	242.7	5	20	0.021	0.082
2501-2600	230.8	3	10	0.013	0.043
2601-2700	210.1	4	8	0.019	0.038
2701-2800	193.1	4	11	0.021	0.057
2801-2900	178.7	7	22	0.039	0.123
2901-3000	160.1	4	14	0.025	0.087
3001-3100	148.6	2	5	0.013	0.034
3101-3200	136.2	2	8	0.015	0.059
3201-3300	119.7	2	8	0.017	0.067
3301-3400	106.1	5	17	0.047	0.160
3401-3500	92.9	3	10	0.032	0.108
3501-3600	81.3	1	4	0.012	0.049
3601-3700	71.6	3	6	0.042	0.084
3701-3800	64.6	2	5	0.031	0.077
3801-3900	55.4	1	2	0.018	0.036
3901-4000	45.0	1	4	0.022	0.089
4001-4100	36.7	5	15	0.136	0.409

TABLE B87 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	0	0	0.000	0.000
501-1000	164.7	1	4	0.006	0.024
1001-1500	198.3	1	4	0.005	0.020
1501-2000	257.0	2	2	0.008	0.008
2001-2500	257.1	10	38	0.039	0.148
2501-3000	194.6	22	65	0.113	0.334
3001-3500	120.7	14	48	0.116	0.398
3501-4000	63.6	8	21	0.126	0.330

TABLE B88

Replacement Rates for Starters on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/o}$ replacement rate for:	
		Maintenance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	4	4	0.026	0.026
201-300	152.0	1	1	0.007	0.007
301-400	152.5	0	0	0.000	0.000
401-500	155.2	2	2	0.013	0.013
501-600	156.7	2	2	0.013	0.013
601-700	160.8	1	1	0.006	0.006
701-800	165.0	0	0	0.000	0.000
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	1	1	0.006	0.006
1101-1200	183.7	1	1	0.005	0.005
1201-1300	196.9	3	3	0.015	0.015
1301-1400	207.0	2	2	0.010	0.010
1401-1500	225.1	3	3	0.013	0.013
1501-1600	241.5	3	3	0.012	0.012
1601-1700	251.7	5	5	0.020	0.020
1701-1800	260.4	2	2	0.008	0.008
1801-1900	263.6	3	3	0.011	0.011
1901-2000	267.6	4	4	0.015	0.015
2001-2100	271.4	5	5	0.018	0.018
2101-2200	266.6	5	5	0.019	0.019
2201-2300	258.1	9	9	0.035	0.035
2301-2400	246.9	5	5	0.020	0.020
2401-2500	242.7	5	5	0.021	0.021
2501-2600	230.8	2	2	0.009	0.009
2601-2700	210.1	1	1	0.005	0.005
2701-2800	193.1	3	3	0.016	0.016
2801-2900	178.7	4	4	0.022	0.022
2901-3000	160.1	4	4	0.025	0.025
3001-3100	148.6	2	2	0.013	0.013
3101-3200	136.2	1	1	0.007	0.007
3201-3300	119.7	1	1	0.008	0.008
3301-3400	106.1	2	2	0.019	0.019
3401-3500	92.9	2	2	0.022	0.022
3501-3600	81.3	2	2	0.025	0.025
3601-3700	71.6	5	5	0.070	0.070
3701-3800	64.6	3	3	0.046	0.046
3801-3900	55.4	5	5	0.090	0.090
3901-4000	45.0	1	1	0.022	0.022
4001-4100	36.7	3	3	0.082	0.082
4101-4200	27.8	0	0	0.000	0.000
4201-4300	20.2	2	2	0.099	0.099
4301-4400	12.6	0	0	0.000	0.000
4401-4500	7.8	1	1	0.128	0.128

TABLE B88 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	7	7	0.046	0.046
501-1000	164.7	3	3	0.018	0.018
1001-1500	198.3	10	10	0.050	0.050
1501-2000	257.0	17	17	0.066	0.066
2001-2500	257.1	29	29	0.113	0.113
2501-3000	194.6	14	14	0.072	0.072
3001-3500	120.7	8	8	0.066	0.066
3501-4000	63.6	16	16	0.252	0.252
4001-4500	21.0	6	6	0.286	0.286

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TABLE B89

Replacement Rates for Idler Wheels on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	1	2	0.007	0.013
201-300	152.0	0	0	0.000	0.000
301-400	152.5	3	5	0.020	0.033
401-500	155.2	3	7	0.019	0.045
501-600	156.7	10	13	0.064	0.083
601-700	160.8	3	3	0.019	0.019
701-800	165.0	25	47	0.152	0.285
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	10	24	0.056	0.134
1101-1200	183.7	5	17	0.027	0.093
1201-1300	196.9	14	23	0.071	0.117
1301-1400	207.0	5	12	0.024	0.058
1401-1500	225.1	5	18	0.022	0.080
1501-1600	241.5	4	11	0.017	0.046
1601-1700	251.7	1	1	0.004	0.004
1701-1800	260.4	6	18	0.023	0.069
1801-1900	263.6	2	4	0.008	0.015
1901-2000	267.6	2	8	0.007	0.030
2001-2100	271.4	2	8	0.007	0.029
2101-2200	266.6	4	11	0.015	0.041
2201-2300	258.1	3	10	0.012	0.039
2301-2400	246.9	8	23	0.032	0.093
2401-2500	242.7	4	11	0.016	0.045
2501-2600	230.8	3	10	0.013	0.043
2601-2700	210.1	4	11	0.019	0.052
2701-2800	193.1	5	17	0.026	0.088
2801-2900	178.7	3	10	0.017	0.056
2901-3000	160.1	2	5	0.012	0.031
3001-3100	148.6	2	5	0.013	0.034
3101-3200	136.2	2	8	0.015	0.059
3201-3300	119.7	1	4	0.008	0.033
3301-3400	106.1	5	20	0.047	0.189
3401-3500	92.9	6	21	0.065	0.226
3501-3600	81.3	2	6	0.025	0.074
3601-3700	71.6	6	21	0.084	0.293
3701-3800	64.6	3	12	0.046	0.186
3801-3900	55.4	4	16	0.072	0.289
3901-4000	45.0	1	2	0.022	0.044
4001-4100	36.7	5	20	0.136	0.545
4101-4200	27.8	2	8	0.072	0.288
4201-4300	20.2	0	0	0.000	0.000
4301-4400	12.6	3	10	0.238	0.794
4401-4500	7.8	1	4	0.128	0.513

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TABLE B89 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	7	14	0.046	0.092
501-1000	164.7	38	63	0.231	0.383
1001-1500	198.3	39	94	0.197	0.474
1501-2000	257.0	15	42	0.058	0.163
2001-2500	257.1	21	63	0.082	0.245
2501-3000	194.6	17	53	0.087	0.272
3001-3500	120.7	16	58	0.133	0.481
3501-4000	63.6	16	57	0.252	0.896
4001-4500	21.0	11	42	0.524	2.000

TABLE B90

Replacement Rates for Road Wheels on M113 APCs in 24th Inf (Mech) Div

Usage interval, miles	Vehicles observed	Quantity of:		$R_{a/e}$ replacement rate for:	
		Mainte-nance actions	Parts replaced	Maintenance actions	Parts replaced
0-100	152.0	0	0	0.000	0.000
101-200	152.0	0	0	0.000	0.000
201-300	152.0	0	0	0.000	0.000
301-400	152.5	1	1	0.007	0.007
401-500	155.2	1	2	0.006	0.013
501-600	156.7	0	0	0.000	0.000
601-700	160.8	0	0	0.000	0.000
701-800	165.0	1	5	0.006	0.030
801-900	167.6	0	0	0.000	0.000
901-1000	173.5	0	0	0.000	0.000
1001-1100	178.9	2	4	0.011	0.022
1101-1200	183.7	0	0	0.000	0.000
1201-1300	196.9	1	1	0.005	0.005
1301-1400	2[illegible].0	1	1	0.005	0.005
1401-1500	225.1	0	0	0.000	0.000
1501-1600	241.5	0	0	0.000	0.000
1601-1700	251.7	0	0	0.000	0.000
1701-1800	260.4	0	0	0.000	0.000
1801-1900	263.6	0	0	0.000	0.000
1901-2000	267.6	1	2	0.004	0.007
2001-2100	271.4	1	5	0.004	0.018
2101-2200	266.6	2	2	0.008	0.008
2201-2300	258.1	0	0	0.000	0.000
2301-2400	246.9	2	14	0.008	0.057
2401-2500	242.7	5	18	0.021	0.074
2501-2600	230.8	1	4	0.004	0.017
2601-2700	210.1	2	8	0.010	0.038
2701-2800	193.1	0	0	0.000	0.000
2801-2900	178.7	1	3	0.006	0.017
2901-3000	160.1	3	7	0.019	0.044
3001-3100	148.6	0	0	0.000	0.000
3101-3200	136.2	0	0	0.000	0.000
3201-3300	119.7	2	2	0.017	0.017
3301-3400	106.1	3	10	0.028	0.094
3401-3500	92.9	2	23	0.022	0.248
3501-3600	81.3	0	0	0.000	0.000
3601-3700	71.6	0	0	0.000	0.000
3701-3800	64.6	1	1	0.015	0.015
3801-3900	55.4	1	8	0.018	0.144
3901-4000	45.0	1	10	0.022	0.222
4001-4100	36.7	2	10	0.054	0.272
4101-4200	27.8	1	2	0.036	0.072
4201-4300	20.2	1	7	0.050	0.347
4301-4400	12.6	1	3	0.079	0.238

TABLE B90 (continued)

Usage interval, miles	Vehicles observed	Quantity of: Maintenance actions	Quantity of: Parts replaced	$R_{a/o}$ replacement rate for: Maintenance actions	$R_{a/o}$ replacement rate for: Parts replaced
0-500	152.7	2	3	0.013	0.020
501-1000	164.7	1	5	0.006	0.030
1001-1500	198.3	4	6	0.020	0.030
1501-2000	257.0	1	2	0.004	0.008
2001-2500	257.1	10	39	0.039	0.152
2501-3000	194.6	7	22	0.036	0.113
3001-3500	120.7	7	35	0.058	0.290
3501-4000	63.6	3	19	0.047	0.299

Appendix C

RESULTS OF LEAST SQUARES ANALYSES OF REPLACEMENT-RATE DATA FOR SELECTED M60 TANK AND M113 APC REPAIR PARTS

Tables

This appendix presents the results of a least squares statistical analysis of the replacement-rate data provided in App B.

In analyzing replacement-rate information for relatively short usage intervals such as 100 miles or 1 month of operation, individual data points are frequently summarized by a single mathematical equation. The summary equation could be of many forms; often the type of rate being studied will help to determine which form(s) to select. For example, if $R_{s/o}$ replacement rates are available for analysis, equations of the type utilized in renewal theory might be chosen to fit to the data.[9] These equations include the exponential distribution

$$R_{\frac{s}{o}} = Ae^{-At} ,$$

the Erlangian distribution

$$R_{\frac{s}{o}} = \frac{A(At)^{B-1}e^{-At}}{(B-1)!} ,$$

the gamma distribution

$$R_{\frac{s}{o}} = \frac{A(At)^{\beta-1}e^{-At}}{\Gamma(\beta)} ,$$

the Weibull distribution

$$R_{\frac{s}{o}} = AB(Bt)^{A-1}e^{-Bt^A} ,$$

the normal distribution

$$R_{\frac{s}{o}} = \frac{1}{\sqrt{2\pi A}}e^{\frac{(Bt)^2}{2A}} ,$$

and the log-normal distribution

$$R_{\frac{s}{o}} = \frac{1}{t\sqrt{2\pi A}}e^{-\frac{\ln(Bt)^2}{2A}} ,$$

The replacement rates presented in App B were of the $R_{a/o}$ type, i.e., rates based on the total number of replacements observed regardless of order. For rates of this kind it was felt that linear ($R_{a/o} = A + Bt$) and log-log ($R_{a/o} = At^B$) functional relationships would be adequate to describe overall replacement trends. For data that are known to be relatively complete and accurate the use of more complex equations such as $R_{a/o} = A + Bt^c$ appears warranted.

The data in App B were analyzed using a Multiple Regression Program developed at RAC.[11] This program is designed to provide great flexibility in acceptable input and to furnish a wide variety of statistics to the user. Among

the items printed out by the program are means; standard deviations; extremes and related statistics; simple, partial, and multiple correlation coefficients; regression coefficients with their standard errors; and measures of significance such as the F ratio and Student's t. Optional data include sums, sums of squares, sums of cross products for raw data, and deviations about means. The program also has the capability of providing output in graphical form. Any two variables may be selected to define the two axes; the variable may be expressed as original data, as transformed data, as estimates computed from the regression equation, or as differences of original and estimated values. The program can accept as many as 74 regression-equation variables, of which any number may be dependent variables. The number of observations that may be used in any run is practically unlimited.

The Multiple Regression Program was used to perform least squares analyses on the detailed replacement-rate information presented in App B. Tables C1–C14 contain the results of data fits based on both the quantity of maintenance actions and the quantity of parts replaced. (In the case of those Federal Stock Numbers for which only one part is used per maintenance action, the equation constants calculated on the two bases are identical.) Each table also lists the number of usage intervals included in the least squares analysis for each repair part and the coefficient of correlation obtained.

The results of the least squares analyses indicated that much better data fits were obtained for some repair parts than for others. These differences in goodness of fit were attributed to a variety of causes. These included the observations that (a) some repair parts (e.g., superchargers) experienced a relatively small number of replacements per vehicle and a relatively large variation in replacement rates from one usage period to another (for repair parts of this type increasing the length of the usage intervals would tend to improve the data fits obtained); and (b) replacement activity for some repair parts such as batteries was more sensitive to the usage measure "months in service" than to the measure "miles of operation."

Although the Support Systems Division data provide indications as to which repair parts experience aging and which usage interval durations and measures are most applicable, it appears premature to make specific recommendations on these questions until similar analyses have been made using TAERS data stored in the Army Logistic Data Bank.

TABLE C1

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected USAREUR M6C Tank Repair Parts

Repair part	Usage intervals observed	Results of log-log fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Road and idler wheel arms	31	0.3741×10^{-3}	0.8127	0.5626	0.5923×10^{-4}	0.1546×10	0.5747
Batteries	31	0.2758×10^{-2}	0.1598	0.1269	0.3173×10^{-2}	0.3807	0.1643
Engines	40	0.2730×10^{-2}	0.6747	0.7856	0.2730×10^{-2}	0.6747	0.7856
Generators	33	0.3325×10^{-2}	0.3368	0.5996	0.3325×10^{-2}	0.3368	0.5996
Final drive hubs	33	0.6001×10^{-4}	0.1631×10	0.7326	0.1467×10^{-3}	0.1478×10	0.7250
Link assemblies	32	0.3648×10^{-3}	0.8167	0.4774	0.3126×10^{-3}	0.9038	0.4839
Fuel injector nozzles	28	0.6309×10^{-2}	0.6463×10^{-1}	0.1277	0.3969×10^{-3}	0.1432×10	0.5158
Fuel injection pumps	33	0.7056×10^{-3}	0.8338	0.4499	0.7056×10^{-3}	0.8338	0.4499
Starter relays	31	0.2943×10^{-1}	−0.3575	0.2510	0.2943×10^{-1}	−0.3575	0.2510
Shock absorbers	37	0.1520×10^{-4}	0.1926×10	0.6723	0.2815×10^{-4}	0.1973×10	0.6751
Track shoes	38	0.3891×10^{-2}	0.8462	0.8601	0.3593	0.9770	0.9119
Sprockets	34	0.5806×10^{-3}	0.1277×10	0.7931	0.7924×10^{-3}	0.1646×10	0.8103
Starters	32	0.3004×10^{-1}	−0.1374	0.3275	0.3004×10^{-1}	−0.1374	0.3275
Transmissions	31	0.8602×10^{-4}	0.1491×10	0.3606	0.8602×10^{-4}	0.1491×10	0.3606
Traverse gear boxes	31	0.5554×10^{-3}	0.8344	0.2558	0.5554×10^{-3}	0.8344	0.2558
Superchargers	27	0.1323×10^{-2}	0.8600×10^{-1}	0.2272	0.1323×10^{-2}	0.8600×10^{-1}	0.2272
Road and idler wheels	40	0.4027×10^{-3}	0.1351×10	0.8790	0.2346×10^{-3}	0.1131×10	0.8733

TABLE C2

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected USAREUR M60 Tank Repair Parts

Repair part	Usage intervals observed	Results of linear fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Road and idler wheel arms	31	0.3161×10^{-3}	0.1940×10^{-3}	0.5305	-0.1458×10^{-2}	0.3976×10^{-3}	0.4462
Batteries	31	0.3181×10^{-2}	0.5524×10^{-4}	0.1627	0.4542×10^{-2}	0.2585×10^{-3}	0.2114
Engines	40	0.4277×10^{-2}	0.7584×10^{-3}	0.7125	0.4277×10^{-2}	0.7584×10^{-3}	0.7125
Generators	33	0.4746×10^{-2}	0.1985×10^{-3}	0.4274	0.4746×10^{-2}	0.1985×10^{-3}	0.4274
Final drive hubs	33	-0.3591×10^{-2}	0.5963×10^{-3}	0.7228	-0.5127×10^{-2}	0.9041×10^{-3}	0.6728
Link assemblies	32	0.7319×10^{-3}	0.1716×10^{-3}	0.5245	0.5262×10^{-3}	0.2067×10^{-3}	0.5441
Fuel injector nozzles	28	0.5984×10^{-2}	0.8976×10^{-4}	0.2119	-0.1310×10^{-2}	0.1544×10^{-2}	0.7501
Fuel injection pumps	33	0.2337×10^{-2}	0.2493×10^{-3}	0.3728	0.2337×10^{-2}	0.2493×10^{-3}	0.3728
Starter relays	31	0.2180×10^{-1}	-0.6185×10^{-3}	0.4727	0.2180×10^{-1}	-0.6185×10^{-3}	0.4727
Shock absorbers	37	-0.3437×10^{-2}	0.4682×10^{-3}	0.6621	-0.8144×10^{-2}	0.1043×10^{-2}	0.5881
Track shoes	38	-0.7596×10^{-3}	0.2367×10^{-2}	0.6434	−0.9395	0.3619	0.6389
Sprockets	34	-0.8914×10^{-2}	0.1802×10^{-2}	0.7269	-0.5875×10^{-1}	0.8934×10^{-2}	0.6669
Starters	32	0.2553×10^{-1}	-0.2304×10^{-3}	0.3164	0.2553×10^{-1}	-0.2304×10^{-3}	0.3164
Transmissions	31	0.2839×10^{-3}	0.3794×10^{-3}	0.6805	0.2839×10^{-3}	0.3794×10^{-3}	0.6805
Traverse gear boxes	31	0.2187×10^{-2}	0.2141×10^{-3}	0.5232	0.2187×10^{-2}	0.2141×10^{-3}	0.5232
Superchargers	27	0.1390×10^{-2}	0.1709×10^{-4}	0.0616	0.1390×10^{-2}	0.1709×10^{-4}	0.0616
Road and idler wheels	40	-0.6969×10^{-2}	0.1579×10^{-2}	0.8279	-0.1647×10^{-1}	0.4256×10^{-2}	0.6770

TABLE C3

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 1-Month Usage Intervals for Selected USAREUR M60 Tank Repair Parts

Repair part	Usage intervals observed	Results of log-log fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Road and idler wheel arms	24	0.2086×10^{-3}	0.1260×10	0.7639	0.1944×10^{-4}	0.2208×10	0.7736
Batteries	24	0.3019×10^{-2}	0.2938	0.1806	0.4353×10^{-6}	0.3662×10	0.2855
Engines	24	0.3433×10^{-2}	0.7593	0.6689	0.3433×10^{-2}	0.7593	0.6689
Generators	24	0.7526×10^{-2}	0.1042	0.1441	0.7626×10^{-2}	0.1042	0.1441
Final drive hubs	23	0.5653×10^{-5}	0.2684×10	0.7987	0.4892×10^{-5}	0.2888×10	0.8019
Link assemblies	25	0.2385×10^{-3}	0.1190×10	0.6287	0.1262×10^{-3}	0.1450×10	0.6408
Fuel injector nozzles	24	0.1210×10^{-1}	−0.1769	0.2628	0.1083×10^{-1}	0.3428	0.0841
Fuel injection pumps	25	0.2382×10^{-2}	0.5447	0.6995	0.2382×10^{-2}	0.5447	0.6995
Starter relays	23	0.3943×10^{-1}	−0.4561	0.2573	0.3943×10^{-1}	−0.4561	0.2573
Shock absorbers	24	0.5811×10^{-5}	0.2510×10	0.8125	0.1869×10^{-4}	0.2377×10	0.8186
Track shoes	25	0.3632×10^{-2}	0.1038×10	0.7922	0.2695	0.1277×10	0.8783
Sprockets	24	0.1650×10^{-2}	0.1054×10	0.7778	0.5567×10^{-2}	0.1071×10	0.8031
Starters	25	0.4935×10^{-1}	−0.2660	0.5986	0.4935×10^{-1}	−0.2660	0.5986
Transmissions	24	0.3683×10^{-2}	0.2616	0.4005	0.3683×10^{-2}	0.2616	0.4005
Traverse gear boxes	23	0.6244×10^{-2}	0.1219×10^{-2}	0.0263	0.6244×10^{-2}	0.1219×10^{-2}	0.0263
Superchargers	23	0.3651×10^{-2}	0.9108×10^{-1}	0.2562	0.3651×10^{-2}	0.9108×10^{-1}	0.2562
Road and idler wheels	25	0.5587×10^{-3}	0.1454×10	0.7897	0.5968×10^{-3}	0.1815×10	0.8119

TABLE C4

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 1-Month Usage Intervals for Selected USAREUR M60 Tank Repair Parts

Repair part	Usage intervals observed	Results of linear fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Road and idler wheel arms	24	-0.5870×10^{-3}	0.4770×10^{-3}	0.7015	0.3022×10^{-2}	0.8517×10^{-3}	0.6489
Batteries	24	0.3268×10^{-2}	0.2252×10^{-3}	0.3810	0.8007×10^{-2}	0.1183×10^{-2}	0.4889
Engines	24	0.3833×10^{-2}	0.1540×10^{-3}	0.6685	0.3833×10^{-2}	0.1540×10^{-2}	0.6685
Generators	24	0.8598×10^{-2}	0.8217×10^{-4}	0.1075	0.8598×10^{-2}	0.8217×10^{-4}	0.1075
Final drive hubs	23	-0.6352×10^{-2}	0.1134×10^{-2}	0.7020	0.1068×10^{-1}	0.1828×10^{-2}	0.6734
Link assemblies	25	0.8600×10^{-3}	0.3646×10^{-3}	0.5394	0.3900×10^{-3}	0.4500×10^{-3}	0.5437
Fuel injector nozzles	24	0.1056×10^{-1}	-0.1993×10^{-3}	0.2768	0.1439×10^{-1}	0.8157×10^{-3}	0.2501
Fuel injection pumps	25	0.3290×10^{-2}	0.4485×10^{-3}	0.6074	0.3290×10^{-2}	0.4485×10^{-3}	0.6074
Starter relays	23	0.2877×10^{-1}	-0.1184×10^{-2}	0.5112	0.2877×10^{-1}	-0.1184×10^{-2}	0.5112
Shock absorbers	24	-0.3775×10^{-2}	0.7287×10^{-3}	0.8623	-0.8217×10^{-2}	0.1547×10^{-2}	0.8294
Track shoes	25	-0.4330×10^{-2}	0.4315×10^{-2}	0.6146	−2.4130	0.7460	0.6625
Sprockets	24	-0.5355×10^{-2}	0.2252×10^{-2}	0.5967	-0.2269×10^{-1}	0.8215×10^{-2}	0.5596
Starters	25	0.3924×10^{-1}	-0.9200×10^{-3}	0.6045	0.3924×10^{-1}	-0.9200×10^{-3}	0.6045
Transmissions	24	0.4714×10^{-2}	0.1696×10^{-3}	0.3781	0.4714×10^{-2}	0.1696×10^{-3}	0.3781
Traverse gear boxes	23	0.6051×10^{-2}	0.1383×10^{-4}	0.0359	0.6051×10^{-2}	0.1383×10^{-4}	0.0359
Superchargers	23	0.4447×10^{-2}	-0.9881×10^{-6}	0.0026	0.4447×10^{-2}	-0.9881×10^{-6}	0.0026
Road and idler wheels	25	-0.7950×10^{-2}	0.2624×10^{-2}	0.8045	-0.3624×10^{-1}	0.8699×10^{-2}	0.8322

TABLE C5

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected 3d Armd Div M60 Tank Repair Parts

Repair part	Usage intervals observed	Results of log-log fit based on: Quantity of replacement maintenance actions — Equation constants A	Equation constants B	Coefficient of correlation	Quantity of parts replaced — Equation constants A	Equation constants B	Coefficient of correlation
Engines	40	0.1458×10^{-2}	0.8462	0.3288	0.1458×10^{-2}	0.8462	0.3288
Track shoes	44	0.8123×10^{-2}	0.6317	0.7047	0.6886	0.7629	0.7614
Sprockets	34	0.1088×10^{-3}	0.1738×10	0.7860	0.3854×10^{-3}	0.1738×10	0.7949
Starters	39	0.7647×10^{-1}	−0.3765	0.0226	0.7647×10^{-1}	−0.3765	0.0226
Road and idler wheels	40	0.1408×10^{-4}	0.2667×10	0.7965	0.1135×10^{-3}	0.1920×10	0.8003

TABLE C6

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected 3d Armd Div M60 Tank Repair Parts

Repair part	Usage intervals observed	Results of linear fit based on: Quantity of replacement maintenance actions — Equation constants A	Equation constants B	Coefficient of correlation	Quantity of parts replaced — Equation constants A	Equation constants B	Coefficient of correlation
Engines	40	0.1942×10^{-2}	0.7979×10^{-3}	0.6020	0.1942×10^{-2}	0.7979×10^{-3}	0.6020
Track shoes	44	0.1422×10^{-1}	0.1799×10^{-2}	0.5415	0.4582	0.2882	0.5999
Sprockets	34	-0.1106×10^{-1}	0.1667×10^{-2}	0.6504	-0.4219×10^{-1}	0.6014×10^{-2}	0.6371
Starters	39	0.5409×10^{-1}	-0.1294×10^{-2}	0.3776	0.5409×10^{-1}	-0.1294×10^{-2}	0.3776
Road and idler wheels	40	-0.1140×10^{-1}	0.1500×10^{-2}	0.8082	0.2837×10^{-1}	0.3648×10^{-2}	0.7240

TABLE C7

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 100- and 500-Mile Usage Intervals for Selected 1st Bn, 33d Armor, 3d Armd Div M60 Tank Repair Parts

Repair part	Usage intervals		Results of log-log fit based on					
			Quantity of replacement maintenance actions			Quantity of parts replaced		
	Length, miles	Number observed	Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
			A	B		A	B	
Engines	100	40	0.5608×10^{-4}	0.1688×10	0.5822	0.5608×10^{-4}	0.1688×10	0.5822
Engines	500	8	0.2861×10^{-2}	0.1841×10	0.4503	0.2861×10^{-2}	0.1841×10	0.4503
Track shoes	100	44	0.2743×10^{-2}	0.9501	0.8099	0.5492	0.8427	0.8070
Track shoes	500	8	0.4440×10^{-1}	0.1125×10	0.8624	0.7691×10	0.1010×10	0.8586
Sprockets	100	31	0.4981×10^{-6}	0.3605×10	0.6362	0.1738×10^{-5}	0.3644×10	0.6367
Sprockets	500	6	0.7150×10^{-7}	0.8922×10	0.8478	0.1734×10^{-6}	0.9201×10	0.8476
Starters	100	40	0.1172	−0.5715	0.0892	0.1172	−0.5715	0.0892
Starters	500	8	0.6020	-0.6260×10	0.1238	0.6020	-0.6260×10	0.1238
Road and idler wheels	100	40	0.1609×10^{-6}	0.3482×10	0.5468	0.1270×10^{-6}	0.3753×10	0.5517
Road and idler wheels	500	8	0.5191×10^{-4}	0.4100×10	0.4608	0.5496×10^{-8}	0.8961×10	0.5067

TABLE C8

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 100- and 500-Mile Usage Intervals for Selected 1st Bn, 33d Armor, 3d Armd Div M60 Tank Repair Parts

Repair part	Usage intervals		Results of linear fit based on					
			Quantity of replacement maintenance actions			Quantity of parts replaced		
	Length, miles	Number observed	Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
			A	B		A	B	
Engines	100	40	-0.3481×10^{-2}	0.7393×10^{-3}	0.6857	-0.3481×10^{-2}	-0.7393×10^{-3}	0.6857
Engines	500	8	-0.2111×10^{-1}	0.1719×10^{-1}	0.8360	-0.2111×10^{-1}	0.1719×10^{-1}	0.8360
Track shoes	100	44	-0.6540×10^{-2}	0.2528×10^{-2}	0.6085	−0.2797	0.3283	0.5416
Track shoes	500	8	-0.7643×10^{-1}	0.6910×10^{-1}	0.6945	−7.8709	9.2174	0.6146
Sprockets	100	31	-0.3162×10^{-1}	0.3547×10^{-2}	0.6504	−0.1261	0.1410×10^{-1}	0.6474
Sprockets	500	6	−0.2243	0.1005	0.7546	−0.8931	0.3994	0.7502
Starters	100	40	0.6433×10^{-1}	-0.1921×10^{-2}	0.3489	0.6433×10^{-1}	-0.1921×10^{-2}	0.3489
Starters	500	8	0.3149	-0.4376×10^{-1}	0.5383	0.3149	-0.4376×10^{-1}	0.5383
Road and idler wheels	100	40	-0.8388×10^{-2}	0.1202×10^{-2}	0.6588	-0.2160×10^{-1}	0.2614×10^{-2}	0.6279
Road and idler wheels	500	8	-0.3943×10^{-1}	0.2726×10^{-1}	0.7099	−0.1285	0.6533×10^{-1}	0.7132

TABLE C9

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected USAREUR M113 APC Repair Parts

Repair part	Usage intervals observed	Results of log-log fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Batteries	39	0.2811×10^{-4}	0.1983×10	0.7130	0.5703×10^{-4}	0.1853×10	0.6966
Ignition coils	40	0.1411×10^{-3}	0.1330×10	0.4615	0.1411×10^{-3}	0.1330×10	0.4615
Differentials	30	0.2257×10^{-2}	0.1988	0.3205	0.2257×10^{-2}	0.1988	0.3205
Distributors	43	0.2607×10^{-3}	0.1177×10	0.6512	0.2607×10^{-3}	0.1177×10	0.6512
Engines	40	0.1905×10^{-3}	0.1203×10	0.3739	0.1905×10^{-3}	0.1203×10	0.3739
Track pads	43	0.1559×10^{-2}	0.9884	0.5334	0.9149×10^{-1}	0.1134×10	0.5989
Radiators	41	0.3661×10^{-3}	0.8885	0.4905	0.3661×10^{-3}	0.8885	0.4905
Road wheel hub seals	35	0.5059×10^{-3}	0.7996	0.5601	0.2820×10^{-3}	0.1124×10	0.5680
Shock absorbers	38	0.4499×10^{-5}	0.2506×10	0.8099	0.1320×10^{-5}	0.2961×10	0.8207
Track shoes	41	0.2754×10^{-4}	0.2215×10	0.8218	0.2053×10^{-3}	0.2881×10	0.8831
Spark plugs	40	0.6073×10^{-2}	0.4998	0.7049	0.1201×10^{-1}	0.8798	0.7388
Sprockets	41	0.2618×10^{-6}	0.3380×10	0.8183	0.8856×10^{-6}	0.3308×10	0.8084
Starters	41	0.2585×10^{-2}	0.7280	0.6753	0.2585×10^{-2}	0.7280	0.6753
Transmissions	41	0.2937×10^{-4}	0.1579×10	0.2220	0.2937×10^{-4}	0.1579×10	0.2220
Idler wheels	42	0.6636×10^{-2}	0.4714	0.6505	0.1472×10^{-4}	0.2575×10	0.7422
Road wheels	44	0.1540×10^{-4}	0.2056×10	0.6890	0.7649×10^{-5}	0.2640×10	0.6982

TABLE C10

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 100-Mile Usage Intervals for Selected USAREUR M113 APC Repair Parts

Repair part	Usage intervals observed	Results of linear fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Batteries	39	-0.5893×10^{-2}	0.1011×10^{-2}	0.7730	-0.6800×10^{-2}	0.1284×10^{-2}	0.7618
Ignition coils	40	0.7462×10^{-3}	0.3660×10^{-3}	0.7159	0.7462×10^{-3}	0.3660×10^{-3}	0.7159
Differentials	30	0.3248×10^{-2}	0.2914×10^{-4}	0.0884	0.3248×10^{-2}	0.2914×10^{-4}	0.0884
Distributors	43	-0.7276×10^{-3}	0.5045×10^{-3}	0.6574	-0.7276×10^{-3}	0.5045×10^{-3}	0.6574
Engines	40	-0.9538×10^{-3}	0.4136×10^{-3}	0.6232	-0.9538×10^{-3}	0.4136×10^{-3}	0.6232
Track pads	43	-0.2150×10^{-2}	0.1572×10^{-2}	0.6739	-0.6982	0.1694	0.6821
Radiators	41	0.1951×10^{-3}	0.2439×10^{-3}	0.5293	0.1951×10^{-3}	0.2439×10^{-3}	0.5293
Road wheel hub seals	35	0.6521×10^{-3}	0.2384×10^{-3}	0.5194	0.8235×10^{-4}	0.4176×10^{-3}	0.5189
Shock absorbers	38	-0.7647×10^{-2}	0.1032×10^{-2}	0.8430	-0.1204×10^{-1}	0.1506×10^{-2}	0.8333
Track shoes	41	-0.1724×10^{-1}	0.2440×10^{-2}	0.8555	-2.2201	0.2177	0.7478
Spark plugs	40	0.1052×10^{-1}	0.7539×10^{-3}	0.5851	0.5577×10^{-1}	0.4901×10^{-2}	0.5776
Sprockets	41	-0.1738×10^{-1}	0.1650×10^{-2}	0.7693	-0.4444×10^{-1}	0.4300×10^{-2}	0.7579
Starters	41	0.6292×10^{-2}	0.8061×10^{-3}	0.6213	0.6292×10^{-2}	0.8061×10^{-3}	0.6213
Transmissions	41	-0.4244×10^{-3}	0.2293×10^{-3}	0.4213	-0.4244×10^{-3}	0.2293×10^{-3}	0.4213
Idler wheels	42	0.1142×10^{-1}	0.7116×10^{-3}	0.4482	0.2366×10^{-2}	0.3561×10^{-2}	0.5762
Road wheels	44	-0.5062×10^{-2}	0.8018×10^{-3}	0.7723	-0.2960×10^{-1}	0.3521×10^{-2}	0.6870

TABLE C11

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 1-Month Usage Intervals for Selected USAREUR M113 APC Repair Parts

Repair part	Usage intervals observed	Results of log-log fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Batteries	24	0.6799×10^{-3}	0.1194×10	0.5879	0.1064×10^{-2}	0.1128×10	0.5520
Ignition coils	22	0.5692×10^{-2}	0.2325	0.5877	0.5692×10^{-2}	0.2325	0.5877
Differentials	19	0.4859×10^{-2}	0.8636×10^{-2}	0.4845	0.4859×10^{-2}	0.8636×10^{-2}	0.4845
Distributors	21	0.6276×10^{-3}	0.1192×10	0.8817	0.6276×10^{-3}	0.1192×10	0.8817
Engines	25	0.5565×10^{-4}	0.1998×10	0.8862	0.5565×10^{-4}	0.1998×10	0.8862
Track pads	23	0.6686×10^{-2}	0.6869	0.8770	0.9155	0.7485	0.8350
Radiators	24	0.2153×10^{-3}	0.1348×10	0.4860	0.2153×10^{-3}	0.1348×10	0.4860
Road wheel hub seals	23	0.1013×10^{-2}	0.8229	0.3956	0.8026×10^{-3}	0.1038×10	0.4259
Shock absorbers	22	0.1949×10^{-3}	0.1711×10	0.6938	0.2255×10^{-3}	0.1802×10	0.7122
Track shoes	23	0.6437×10^{-2}	0.6582	0.8525	0.2427	0.1039×10	0.8214
Spark plugs	23	0.1607×10^{-1}	0.3064	0.8517	0.9004×10^{-1}	0.3425	0.7643
Sprockets	24	0.8237×10^{-4}	0.1978×10	0.9032	0.1031×10^{-3}	0.2251×10	0.9026
Starters	22	0.9410×10^{-2}	0.4816	0.5236	0.9410×10^{-2}	0.4816	0.5236
Transmissions	22	0.1122×10^{-2}	0.5840	0.3909	0.1122×10^{-2}	0.5840	0.3909
Idler wheels	23	0.3190×10^{-1}	0.4930	0.1226	0.4001×10^{-1}	0.3746	0.4369
Road wheels	22	0.6976×10^{-3}	0.1170×10	0.8505	0.3367×10^{-4}	0.2726×10	0.8640

TABLE C12

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 1-Month Usage Intervals for Selected USAREUR M113 APC Repair Parts

Repair part	Usage intervals observed	Results of linear fit based on					
		Quantity of replacement maintenance actions			Quantity of parts replaced		
		Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
		A	B		A	B	
Batteries	24	-0.1312×10^{-2}	0.1268×10^{-2}	0.8009	-0.1036×10^{-2}	0.1600×10^{-2}	0.7607
Ignition coils	22	0.6935×10^{-2}	0.2270×10^{-3}	0.2494	0.6935×10^{-2}	0.2270×10^{-3}	0.2494
Differentials	19	0.6351×10^{-2}	-0.1404×10^{-3}	0.1853	0.6351×10^{-2}	-0.1404×10^{-3}	0.1853
Distributors	21	-0.1891×10^{-2}	0.1194×10^{-2}	0.7972	-0.1891×10^{-2}	0.1194×10^{-2}	0.7972
Engines	25	-0.5370×10^{-2}	0.1376×10^{-2}	0.7104	-0.5370×10^{-2}	0.1376×10^{-2}	0.7104
Track pads	23	0.6004×10^{-2}	0.2387×10^{-2}	0.6733	0.1701	0.4395	0.4578
Radiators	24	-0.9565×10^{-3}	0.6465×10^{-3}	0.6430	-0.9565×10^{-3}	0.6465×10^{-3}	0.6430
Road wheel hub seals	23	0.1478×10^{-2}	0.5217×10^{-3}	0.6167	0.4980×10^{-3}	0.8607×10^{-3}	0.6360
Shock absorbers	22	-0.7130×10^{-2}	0.1912×10^{-2}	0.7857	-0.1251×10^{-1}	0.2985×10^{-2}	0.7761
Track shoes	23	0.7814×10^{-2}	0.1968×10^{-2}	0.6940	-0.7289	0.3173	0.5209
Spark plugs	23	0.2052×10^{-1}	0.1026×10^{-2}	0.7531	0.1178	0.6884×10^{-2}	0.6366
Sprockets	24	-0.1001×10^{-1}	0.2021×10^{-2}	0.7832	-0.2917×10^{-1}	0.5747×10^{-2}	0.8715
Starters	22	0.1312×10^{-1}	0.1405×10^{-2}	0.5150	0.1312×10^{-1}	0.1405×10^{-2}	0.5150
Transmissions	22	0.1364×10^{-2}	0.2648×10^{-3}	0.4682	0.1364×10^{-2}	0.2648×10^{-3}	0.4682
Idler wheels	23	0.3398×10^{-1}	0.1393×10^{-3}	0.0506	0.5130×10^{-1}	0.3783×10^{-2}	0.4071
Road wheels	22	-0.8442×10^{-3}	0.1176×10^{-2}	0.8184	-0.2481×10^{-1}	0.6339×10^{-2}	0.8088

TABLE C13

Log-Log Fit of $R_{a/o}$ Replacement-Rate Data Based on 100- and 500-Mile Usage Intervals for Selected 24th Inf (Mech) Div M113 APC Repair Parts

Repair part	Usage intervals		Results of log-log fit based on					
			Quantity of replacement maintenance actions			Quantity of parts replaced		
	Length, miles	Number observed	Equation constants		Coefficient of correlation	Equation constants		Coefficient of correlation
			A	B		A	B	
Batteries	100	41	0.6777×10^{-7}	0.3565×10	0.6185	0.4946×10^{-6}	0.3092×10	0.6231
Batteries	500	8	0.1049×10^{-4}	0.4611×10	0.9389	0.4514×10^{-5}	0.5212×10	0.9486
Distributors	100	42	0.5042×10^{-1}	0.5445×10	0.6466	0.5042×10^{-1}	0.5445×10	0.6446
Distributors	500	8	0.3183×10^{-2}	0.1426×10	0.8956	0.3183×10^{-2}	0.1426×10	0.8956
Engines	100	40	0.2255×10^{-4}	0.1830×10	0.3215	0.2255×10^{-4}	0.1830×10	0.3215
Engines	500	8	0.7431×10^{-3}	0.2326×10	0.8724	0.7431×10^{-3}	0.2326×10	0.8724
Track pads	100	43	0.1640×10^{-2}	0.1020×10	0.6684	0.2765×10^{-5}	4.0044	0.6590
Track pads	500	8	0.1375×10^{-1}	0.1649×10	0.8955	0.1381×10^{-2}	0.1694×10	0.8760
Road wheel hub seals	100	35	0.2293×10^{-2}	0.2970	0.2960	0.2021×10	0.5054	0.3073
Road wheel hub seals	500	7	0.1503×10^{-1}	0.4055	0.5658	0.1264×10^{-1}	0.8755	0.6607
Shock absorbers	100	38	0.3613×10^{-5}	0.2303×10	0.4419	0.1633×10^{-5}	1.9245	0.4538
Shock absorbers	500	7	0.3649×10^{-2}	0.1247×10	0.8579	0.1983×10^{-2}	0.1832×10	0.8794
Track shoes	100	35	0.5577×10^{-6}	0.3366×10	0.8039	0.1876×10^{-4}	0.3605×10	0.8700
Track shoes	500	7	0.1093×10^{-2}	0.2934×10	0.9308	0.3569×10^{-1}	0.3387×10	0.9890
Spark plugs	100	40	0.1794×10^{-3}	0.1483×10	0.5567	0.2240×10^{-2}	0.1303×10	0.5819
Spark plugs	500	8	0.7128×10^{-2}	0.1602×10	0.9599	0.6613×10^{-1}	0.1430×10	0.9773
Sprockets	100	40	0.1493×10^{-4}	0.2088×10	0.7225	0.6300×10^{-4}	0.1995×10	0.7160
Sprockets	500	8	0.1434×10^{-2}	0.2213×10	0.9450	0.6451×10^{-2}	0.2001×10	0.9090
Starters	100	36	0.3131×10^{-2}	0.5003	0.5222	0.3131×10^{-2}	0.5003	0.5222
Starters	500	7	0.3266×10^{-1}	0.4849	0.6047	0.3266×10^{-1}	0.4849	0.6047
Idler wheels	100	40	0.1788×10^{-1}	0.1553	0.5083	0.6527×10^{-2}	0.8145	0.5693
Idler wheels	500	8	0.1045	0.1916	0.3354	0.9587×10^{-1}	0.8994	0.6561
Road wheels	100	40	0.1576×10^{-4}	0.1877×10	0.3363	0.6390×10^{-5}	1.6603	0.3563
Road wheels	500	8	0.3729×10^{-2}	0.1292×10	0.6152	0.2172×10^{-2}	0.2404×10	0.7095

TABLE C14

Linear Fit of $R_{a/o}$ Replacement-Rate Data Based on 100- and 500-Mile Usage Intervals for Selected 24th Inf (Mech) Div M113 APC Repair Parts

Repair part	Usage intervals		Results of linear fit based on					
			Quantity of replacement maintenance actions			Quantity of parts replaced		
	Length, miles	Number observed	Equation constants A	Equation constants B	Coefficient of correlation	Equation constants A	Equation constants B	Coefficient of correlation
Batteries	100	41	-0.7733×10^{-2}	0.7991×10^{-3}	0.6341	-0.1057×10^{-1}	0.1084×10^{-2}	0.6231
Batteries	500	8	-0.4214×10^{-1}	0.1839×10^{-1}	0.8532	-0.6425×10^{-1}	0.2700×10^{-1}	0.8340
Distributors	100	42	-0.4254×10^{-2}	0.5500×10^{-3}	0.6295	-0.4254×10^{-2}	0.5500×10^{-3}	0.6295
Distributors	500	8	-0.9929×10^{-2}	0.8679×10^{-2}	0.9795	-0.9929×10^{-2}	0.8679×10^{-2}	0.9795
Engines	100	40	-0.2046×10^{-2}	0.4584×10^{-3}	0.5994	-0.2046×10^{-2}	0.4584×10^{-3}	0.5994
Engines	500	8	-0.1525×10^{-1}	0.1158×10^{-1}	0.8496	-0.1525×10^{-1}	0.1158×10^{-1}	0.8496
Track pads	100	43	-0.4472×10^{-2}	0.1908×10^{-2}	0.6619	-0.4556	0.2004	0.6188
Track pads	500	8	-0.8414×10^{-1}	0.6014×10^{-1}	0.9571	-10.1984	6.7386	0.9366
Road wheel hub seals	100	35	0.3308×10^{-2}	0.3308×10^{-2}	0.2167	0.3264×10^{-2}	0.2742×10^{-3}	0.2481
Road wheel hub seals	500	7	0.1386×10^{-1}	0.2857×10^{-2}	0.4305	0.4000×10^{-2}	0.9464×10^{-2}	0.6572
Shock absorbers	100	38	-0.1693×10^{-2}	0.3648×10^{-3}	0.4949	-0.7684×10^{-2}	0.8947×10^{-3}	0.5104
Shock absorbers	500	7	-0.4286×10^{-2}	0.6393×10^{-2}	0.9023	-0.1471×10^{-1}	0.1121×10^{-1}	0.8716
Track shoes	100	35	-0.1058×10^{-1}	0.1962×10^{-2}	0.7978	-1.5460	0.1742	0.8295
Track shoes	500	7	-0.6329×10^{-1}	0.4607×10^{-1}	0.8672	-8.6567	4.1300	0.9162
Spark plugs	100	40	-0.3223×10^{-2}	0.1045×10^{-2}	0.6642	-0.2027×10^{-1}	0.6995×10^{-2}	0.6828
Spark plugs	500	8	-0.2707×10^{-1}	0.2632×10^{-1}	0.9345	-0.1725	0.1755	0.9611
Sprockets	100	40	-0.7588×10^{-2}	0.8897×10^{-3}	0.7847	-0.2220×10^{-1}	0.2288×10^{-2}	0.7608
Sprockets	500	8	-0.4411×10^{-1}	0.2127×10^{-1}	0.9207	-0.1241	0.6264×10^{-1}	0.9017
Starters	100	36	0.5589×10^{-2}	0.3946×10^{-3}	0.4822	0.5589×10^{-2}	0.3946×10^{-3}	0.4822
Starters	500	7	0.2857×10^{-1}	0.8250×10^{-2}	0.6132	0.2857×10^{-1}	0.8250×10^{-2}	0.6132
Idler wheels	100	40	0.2134×10^{-1}	0.3079×10^{-3}	0.1212	0.2005×10^{-1}	0.2764×10^{-2}	0.4039
Idler wheels	500	8	0.1011	0.7690×10^{-2}	0.2331	0.7607×10^{-1}	0.6660×10^{-1}	0.6469
Road wheels	100	40	-0.1269×10^{-2}	0.3619×10^{-3}	0.5302	-0.2174×10^{-1}	0.2404×10^{-2}	0.4959
Road wheels	500	8	-0.3250×10^{-2}	0.6917×10^{-2}	0.8479	-0.7757×10^{-1}	0.4340×10^{-1}	0.8864

Appendix D

DESCRIPTION OF EXPECTED NUMBER OF ACTIONS COMPUTER ROUTINE

INTRODUCTION

The major steps in the study's repair-parts forecasting methodology have been discussed in Chaps. 2 to 4. In addition to standard sort and extract routines, four other computer routines are required to process the data automatically. These routines are summarized in Fig. D1. The Events Rates Routine, described in App A, requires input data of the type "part X was replaced on vehicle Y at usage Z"; in turn it furnishes replacement-rate data for the Least Squares Statistical Analysis Routine (App C).

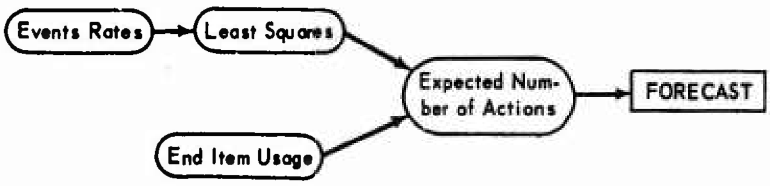


Fig. D1—Summary of Computer Routines Used in Predicting Repair-Parts Replacement

Appendix D describes the Expected Number of Actions Routine developed by study analysts to combine usage-dependent replacement rates and end-item usage data to predict repair-parts replacement during any period of interest. This appendix also presents a brief description of the auxiliary End Item Usage Routine developed to compute vehicle usage distributions.

The first half of the appendix is devoted to a general description of procedures for estimating parts replacement and the second half to detailed descriptions of the Expected Number of Actions Routine and the End Item Usage Routine.

GENERAL DESCRIPTION

The two types of replacement rates discussed in detail in Chap. 2 were the $R_{s/e}$ and the $R_{a/o}$ rates. Forecasting procedures based on each of these rates are considered below.

The $R_{s/e}$ rate measures the number of observed events of a specified order per vehicle available to experience events of that order. A plot of first-order $R_{s/e}$ rates for M60 tank-engine replacements for each 100 miles of operation observed is shown in Fig. D2; these rate data were obtained from Table 12. Using least squares techniques different types of curves can be fitted to these data. A linear fit, for example, could be represented by $R(t) = A + Bt$.

If there are N_1 engines available to experience first-order replacements at time t_1 and N_2 engines at time t_2, the number of replacements in usage interval $t_2 - t_1$ is $N_1 - N_2$. For each usage interval the $R_{s/e}$ rates can be represented as $-\Delta N/N\Delta t$. For usage intervals of short duration, with a linear

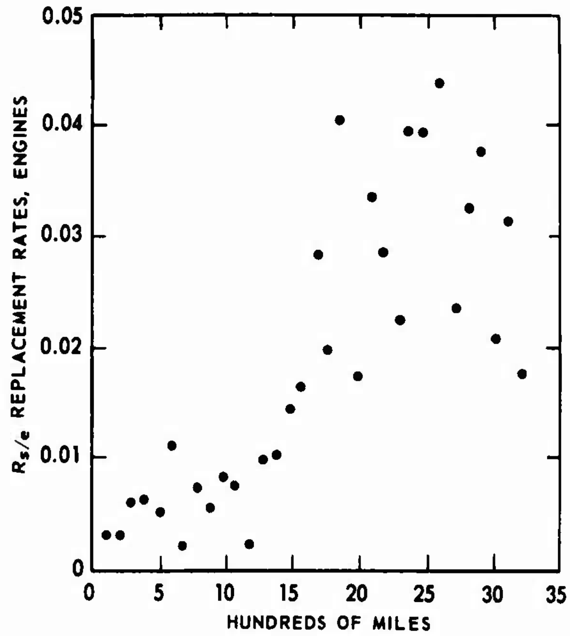


Fig. D2—First-Order Replacement Rates for USAREUR M60 Tank Engines

variation of rates, the following equation applies: $-dN/N \cdot 1/dt = A + Bt$. Integrating,

$$\Big[\ln N\Big]_{N_1}^{N_2} = -\left[At + \frac{Bt^2}{2}\right]_{t_1}^{t_2}$$

from which it follows that

$$N_2 = N_1 e^{-\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right]}$$

and by subtracting N_1 from each side of the equation

$$N_2 - N_1 = N_1\left[e^{-\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right]} - 1\right].$$

Since the expected number of replacements in $t_2 - t_1$ is $N_1 - N_2$,

$$N_1 - N_2 = N_1\left[1 - e^{-\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right]}\right].$$

Similar expressions can be derived for other types of least squares functional relations. Equations for calculating the expected number of replacements of a given order based on constant, linear, log-log, and semilog replacement rates are summarized in Table D1.

The equations shown in Table D1 apply to a single order of replacement. To calculate the total number of replacements expected, all orders of replacement must be considered. One method of using $R_{s/e}$ rates to estimate the total quantity of repair parts replaced is to apply renewal-theory techniques.[9] In renewal theory terminology, $R_{s/e}$ rates are frequently referred to as "age-specific failure rates" or as "hazard rates"; equations have been developed to allow calculations of the total number of replacements from the distribution of times to first failure. In using renewal theory equations it is assumed that replacement components will exhibit the same time-to-failure pattern as original components (an ordinary renewal process) or will provide some known fraction of like-new performance (a modified renewal process).[9]

TABLE D1

Summary of Forecasting Equations Based on $R_{s/e}$ Replacement Rates

Type of replacement-rate curve considered		Equation for calculating the expected number of replacements of a given order, $E(R)$, during usage period $t_2 - t_1$
Common name	Math notation	
Average	$R_{s/e} = A$	$E(R) = N_1\left[1 - e^{-A(t_2 - t_1)}\right]$
Linear	$R_{s/e} = A + Bt$	$E(R) = N_1\left\{1 - e^{-\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right]}\right\}$
Log-log	$R_{s/e} = At^B$	$E(R) = N_1\left[1 - e^{-\frac{A}{B+1}\left(t_2^{B+1} - t_1^{B+1}\right)}\right]$
Semilog	$R_{s/e} = AB^t$	$E(R) = N_1\left[1 - e^{-\frac{A}{\ln B}\left(B^{t_2} - B^{t_1}\right)}\right]$

In those cases in which the distribution of times to first failures can be identified accurately and in which subsequent-order failures occur according to the criteria specified for ordinary or for modified renewal processes, renewal-theory techniques can be extremely useful in providing long-range forecasts of repair-parts consumption. For a number of reasons, however, the forecasting methodology described in this technical memorandum was not based on already established renewal-theory techniques. These reasons can be summarized as follows:

(a) For many repair parts of interest, TAERS-type data either do not extend back to the introduction of a given end item of equipment or do not contain sufficient information to allow reconstruction of the first-failure time distribution.

(b) Even if data are sufficient to permit identification of failures, the assumption that replacement components furnish like-new performance (as measured in terms of time to failure) does not appear valid for selected tank and APC components.[12,13]

(c) Even in cases where this assumption is valid and for which sufficient data are available, the effort required to identify the distribution of first-failure times may not be warranted for short-term consumption forecasts that extend only a few quarters into the future.

For these reasons, a simplified methodology based on less restrictive assumptions and data requirements was developed. This methodology provides a procedure for projecting replacements (regardless of order) into future time periods; it combines usage-dependent replacement rates of the $R_{a/o}$ type with projections of end-item usage. As will be recalled, the $R_{a/o}$ replacement rate measures the total number of repair parts of a given type that were replaced per vehicle observed. Figure D3 indicates the linear curve that best fits the engine-replacement-rate data ($R_{a/o}$) for the M60 tank according to least squares criteria. Once again the following equation can be specified: $-dN/N \cdot 1/dt = A + Bt$.

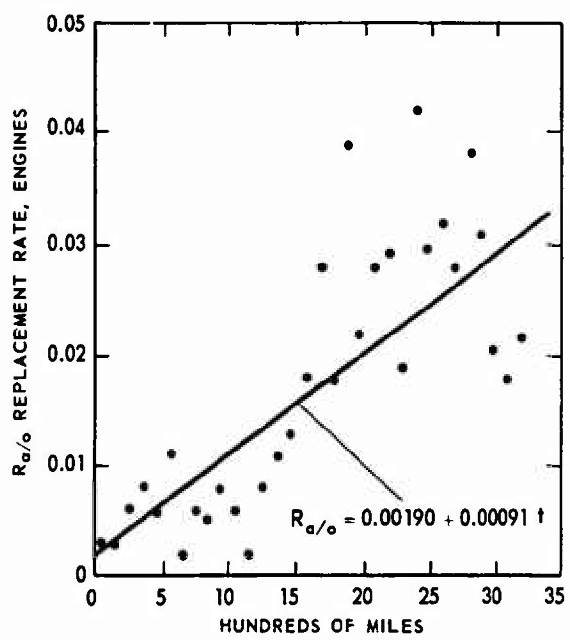


Fig. D3—Linear Replacement-Rate Curve Fitted to USAREUR M60-Tank-Engine Replacement Data

In this case, however, the number of vehicles (N) available to experience an engine replacement of any order is independent of previous engine-replacement experience. Therefore, for the forecast period $t_2 - t_1$,

$$-dN = N_1(A + Bt)dt.$$

Integrating,

$$\Big[N\Big]_{N_1}^{N_2} = -N_1\left[At + \frac{Bt^2}{2}\right]_{t_1}^{t_2}$$

from which it follows that

$$N_2 - N_1 = -N_1\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right].$$

Since the expected number of replacements is $N_1 - N_2$,

$$N_1 - N_2 = N_1\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right].$$

A summary of forecasting equations based on $R_{a/o}$ replacement rates is provided in Table D2. Each equation presented in Table D2 considers three

TABLE D2

Summary of Forecasting Equations Based on $R_{a/o}$ Replacement Rates

Type of replacement-rate curve considered		Equation for calculating the expected number of replacements of all orders, $E(R)$, during usage period $t_2 - t_1$
Common name	Math notation	
Average	$R_{a/o} = A$	$E(R) = N_1 A(t_2 - t_1)$
Linear	$R_{a/o} = A + Bt$	$E(R) = N_1\left[A(t_2 - t_1) + \frac{B}{2}(t_2^2 - t_1^2)\right]$
Log-log	$R_{a/o} = At^B$	$E(R) = N_1\left(\frac{A}{B+1}\right)\left(t_2^{B+1} - t_1^{B+1}\right)$
Semilog	$R_{a/o} = AB^t$	$E(R) = N_1\left(\frac{A}{\ln B}\right)\left(B^{t_2} - B^{t_1}\right)$

types of information: (a) replacement-rate constants (A or A and B) determined by fitting curves to replacement-rate data for relatively short usage intervals such as 100 miles of operation, (b) the duration of the forecast period $(t_2 - t_1)$ specified by the reliability or commodity analyst, and (c) the number of vehicles N_1 falling in the first usage interval at the beginning of the forecast period.

The manner in which the forecasting equations are applied to an entire distribution of vehicle mileages is illustrated in Table D3. In this hypothetical example, patterned after that presented in Table 16, the projection of part X consumption is based on the linear curve $R_{a/o} = 0.01 + 0.01t$. The youngest vehicles in this example have accumulated 901 to 1000 miles of operation at the beginning of the forecast period that extends for another 900 miles, or nine usage intervals.

DETAILED DESCRIPTION

Details concerning the capabilities and utilization of the Expected Number of Actions Routine and the End Item Usage Routine are summarized below.

TABLE D3

Expected Replacement of Part X Required for Fleet of 60 Vehicles for 900 Miles of Operation

Usage interval, miles	Beginning of forecast period (t_1)	End of forecast period (t_2)	Vehicles (N_1) in usage interval	$A(t_2-t_1)$	$\frac{B}{2}(t_2^2-t_1^2)$	Expected replacements $E(R)$ based on linear curve
0–100	1	10	0	0.09	0.50	0
101–200	2	11	0	0.09	0.59	0
201–300	3	12	0	0.09	0.68	0
301–400	4	13	0	0.09	0.77	0
401–500	5	14	0	0.09	0.86	0
501–600	6	15	0	0.09	0.95	0
601–700	7	16	0	0.09	1.04	0
701–800	8	17	0	0.09	1.13	0
801–900	9	18	0	0.09	1.22	0
901–1000	10	19	5	0.09	1.31	7.00
1001–1100	11	20	10	0.09	1.40	14.90
1101–1200	12	21	15	0.09	1.49	23.70
1201–1300	13	22	15	0.09	1.58	25.05
1301–1400	14	23	10	0.09	1.67	17.60
1401–1500	15	24	5	0.09	1.76	9.25
Totals			60			97.50

Expected Number of Actions Routine

A detailed flow chart describing the major sections of the Expected Number of Actions Routine is presented in Fig. D4. This IBM 7040 routine is designed to provide the user with the capability of making many runs with a minimum number of additional input requirements. This is accomplished by the use of control cards that determine the input required for a particular run and also indicate when computation should begin and when all the runs have been completed.

In addition to control cards, certain input data cards are also required. These are summarized in Table D4. The next sections of this appendix present detailed descriptions of the control and data cards for the Expected Number of Actions Routine.

Control Cards. Control cards are used as program input to direct the program to the various branches for proper processing. They are used to indicate that data of a particular type follow, that a data group is finished, that the computation phase of the program is desired, or that no more runs are required.

Meanings of specific control words.

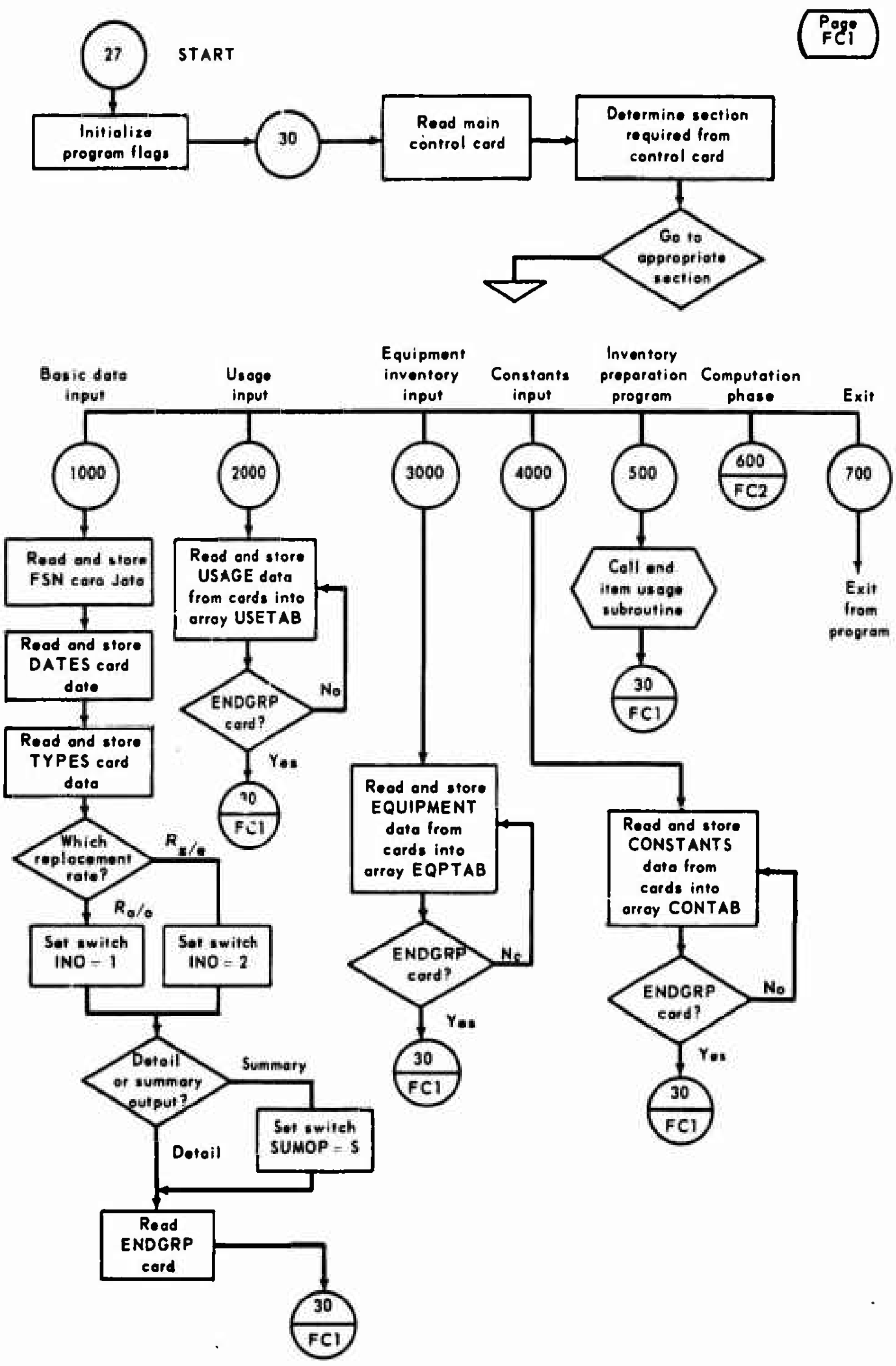
BASIC. FSN data card, DATES data card, and TYPES data card follow in that order.

USAGE. USAGE data cards follow.

EQUIPMENT. EQUIPMENT data cards follow.

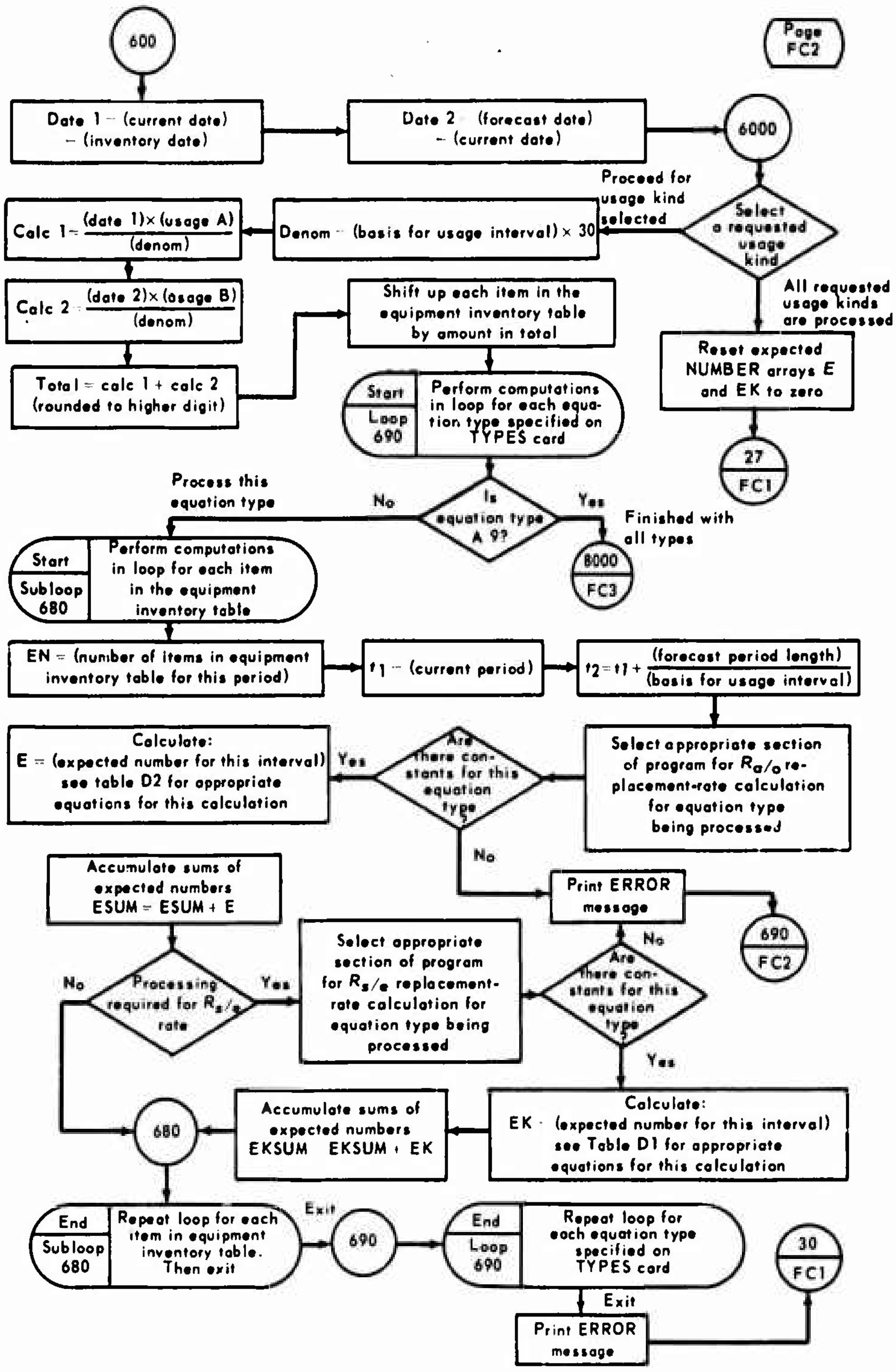
CONSTANTS. CONSTANTS data cards follow.

INVENTORY. End Item Usage Routine is to be called to form the Equipment Inventory Table.



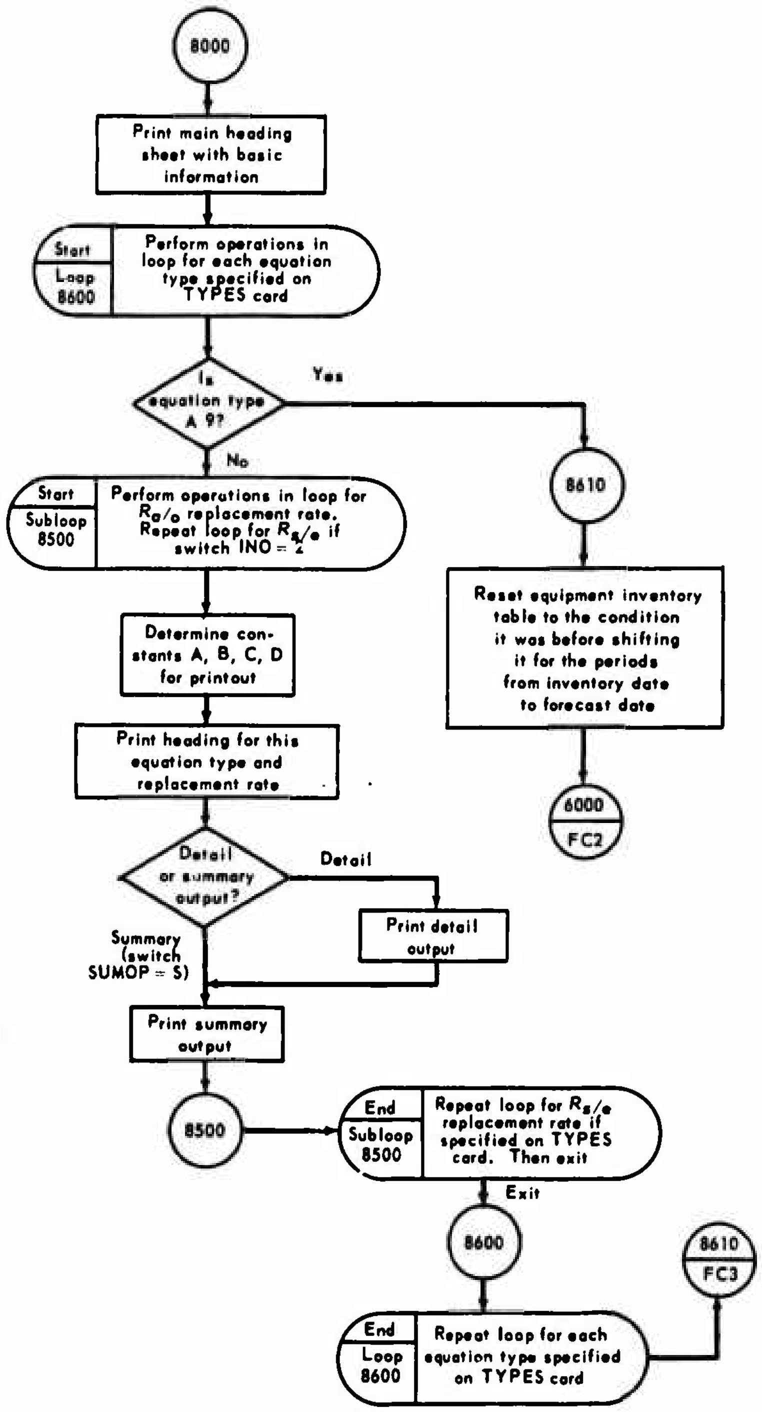
a. Main Control and Selection Section

Fig. D4—Flow Chart for Expected Number of Actions Routine



b. Computation Section

Fig. D4—Continued



c. Printout Section

Fig. D4—Continued

TABLE D4

Summary of Input Data Required for Expected Number of Actions Routine

Card type	Input information contained on cards of this type
FSN	Repair part FSN
	End item FSN
DATES	User organization
	Inventory date
	Current date
	Beginning date of forecast period
TYPES	Type of equation(s) to be applied
	Type of replacement rate(s) to be used
EQUIPMENT	Usage units for equipment inventory table
	Length of forecast period
	Utilization rate from inventory to current date
	Utilization rate from current date to beginning date of forecast period
CONSTANTS	Constants for expected value equations

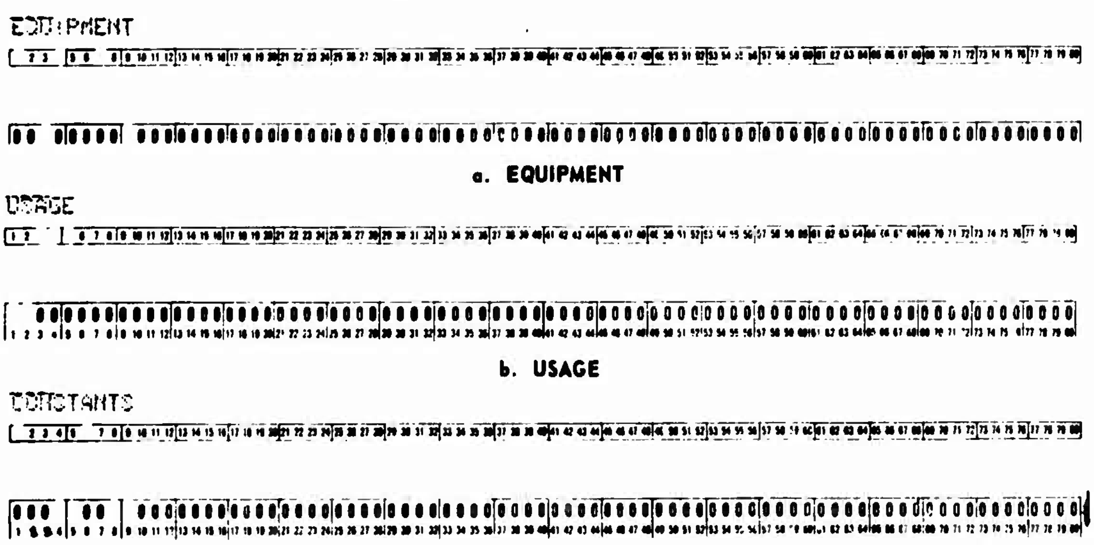
COMPUTE. All pertinent data for a run have been entered and the computation phase is to be entered.

ENDGRP. A particular group of data cards is ended; this card is required at the end of every data group entered.

ENDRUN. No more runs are required and the program should terminate; this card is required as the very last card of all input cards.

The control words are punched on the cards starting in col 1. Nothing else is punched on the card.

Examples of control cards.



a. EQUIPMENT

b. USAGE

c. CONSTANTS

Fig. D5—Examples of Control Cards

Input Data Cards.

FSN. This card contains the end-item FSN, repair-part FSN, and an option number to indicate a title that is printed with the output heading. It immediately follows the BASIC control card.

The option number that is punched causes the title to be printed as follows:

Option number	Title
1	Parts replaced
2	Replacement actions
3	Parts repaired
4	Repair actions
5	Parts adjusted
6	Adjustment actions

The letters FSN must be punched in cols 1 to 3 as shown in Fig. D6.

DATES. This card contains the using organization (for printout purposes), the inventory date, the current date, and the beginning date of the forecast period to be studied. All dates are expressed as Julian dates. This card is placed immediately behind the FSN card. The letters DATES must be punched in cols 1 to 5 as shown in Fig. D7.

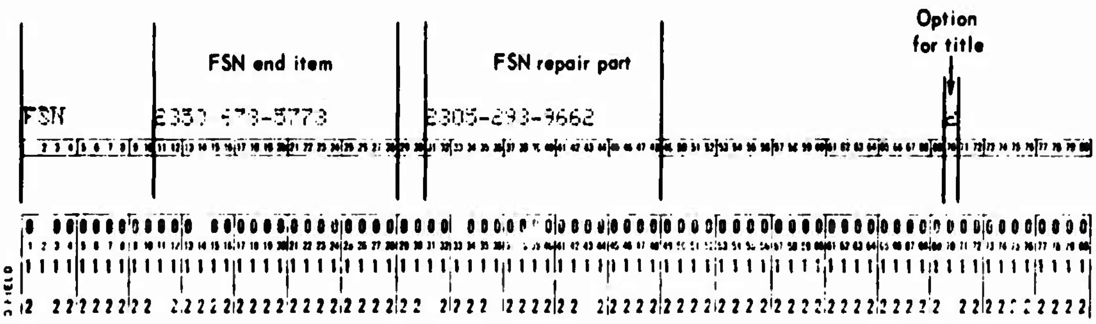


Fig. D6—Format for FSN Data Cards

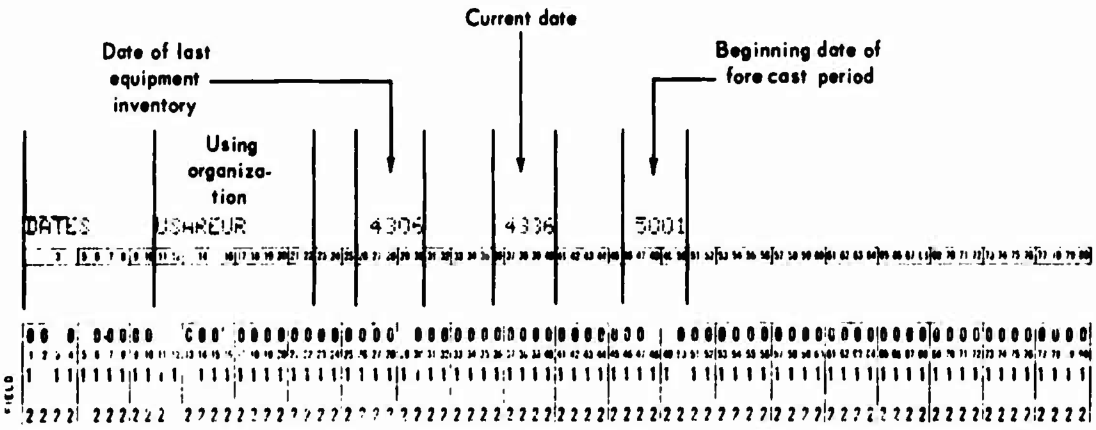


Fig. D7—Format for DATES Data Cards

TYPES. This card contains codes for the types of equations to be used by the program in computing the expected values, the type of replacement rate considered, and the type of output desired. It is placed immediately behind the DATES data card.

The types of equations considered by the program can be selected by punching code numbers in cols 11 to 19. The code numbers and related equations are

Code	Equations
1	Constant
2	Linear
3	Quadratic
4	Cubic
5	(Nothing at present)
6	Semilog
7	Log-log
8	(Nothing at present)
9	No more equations to be processed

These code numbers are punched starting in col 11, proceeding to the right. When no more requests are desired, the code "9" is punched and the rest of the field should be filled with 9's (through col 19). This card must be followed by an ENDGRP control card since it is the last card of a data group. The letters TYPES must be punched in cols 1 to 5 as shown in Fig. D8.

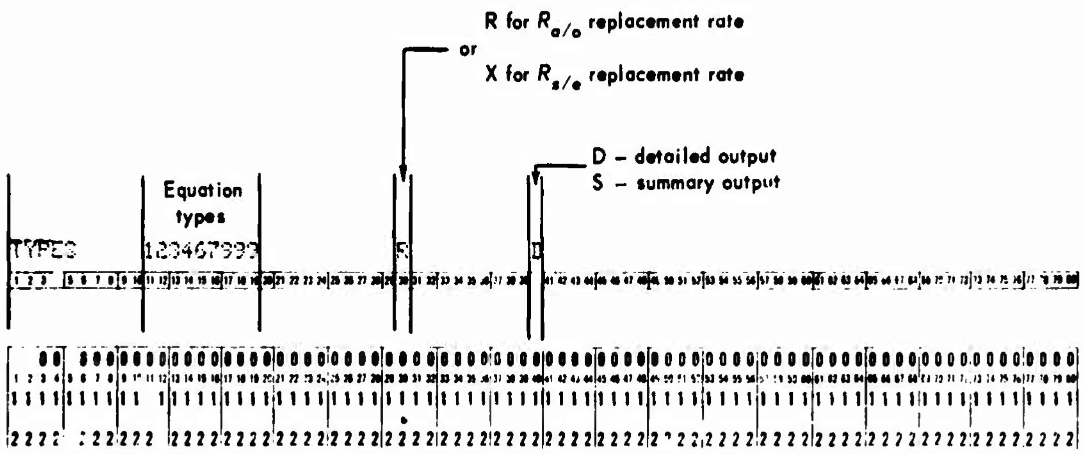


Fig. D8—Format for TYPES Data Cards

USAGE. These cards contain information related to the usage units for a run, the basis for the usage interval, monthly usage rates from the inventory date to current date and from current date to forecast date, and the length of the forecast period.

The usage units measure can be months, miles, hours, or rounds. This is indicated by punching a code word in the first field of the card:

Code	Units
UMONTH	Months
UMILE	Miles
UHOUR	Hours
UROUND	Rounds

The various fields on the card are defined as follows:

<u>basis for usage interval.</u> The number of units that define an interval in the equipment inventory table.
<u>usage A.</u> The rate of end-item utilization (in units per interval) from date of inventory to date of the study.
<u>usage B.</u> The rate of end-item utilization (in units per interval) from the date of the study to the beginning date of the forecast period.
<u>length of forecast period examined.</u> The number of units (months, miles, hours, or rounds) in the forecast period.

As many cards of this type are prepared and grouped together as there are usage measures considered (a maximum of four). These cards are placed immediately after a USAGE control card. An ENDGRP card immediately follows these cards (Fig. D9).

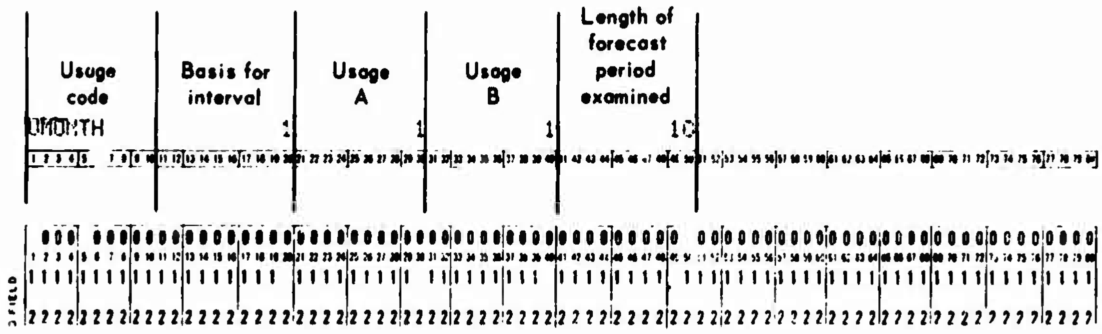


Fig. D9—Format for USAGE Data Cards

EQUIPMENT. These cards contain data for the equipment inventory table for any of the four usage measures being considered. Each card contains the interval number in the table and the required data to be entered into the table for each usage measure. Only the fields pertaining to the appropriate usage measures being considered need to be punched.

As many of these cards are prepared as are required for the equipment inventory table (a maximum of 100). They are placed immediately after an EQUIPMENT control card and are immediately followed by an ENDGRP control card. The letters EQPMNT must be punched in cols 1 to 6 of the card (Fig. D10).

CONSTANTS. These cards contain the constants required for the calculations of the expected values. These constants had to be previously determined from a curve fit for the particular equation type indicated on the card. The

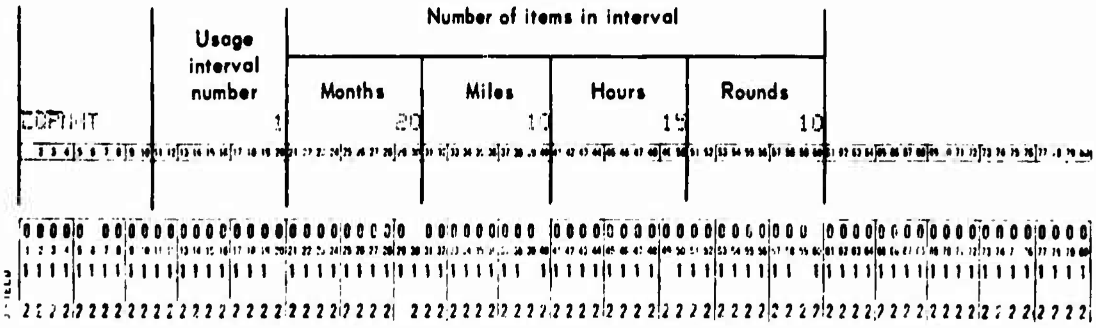


Fig. D10—Format for EQUIPMENT Data Cards

constants that are punched will refer to equations for usage measure, replacement rate type, and equation type.

The usage measure is indicated by punching a code word in the first field of the card.

Code	Units
CMONTH	Months
CMILE	Miles
CHOUR	Hours
CROUND	Rounds

The type of replacement rate is punched as an X or R with the following meaning:

R—$R_{a/o}$ replacement rate only to be used
X—$R_{s/e}$ and $R_{a/o}$ replacement rates to be used

The equation types to which the constants apply are defined the same as for the TYPES data card. One of these data cards is required for each equation type being considered. These cards are placed immediately after a CONSTANTS control card and are followed immediately by an ENDGRP card (Fig. D11).

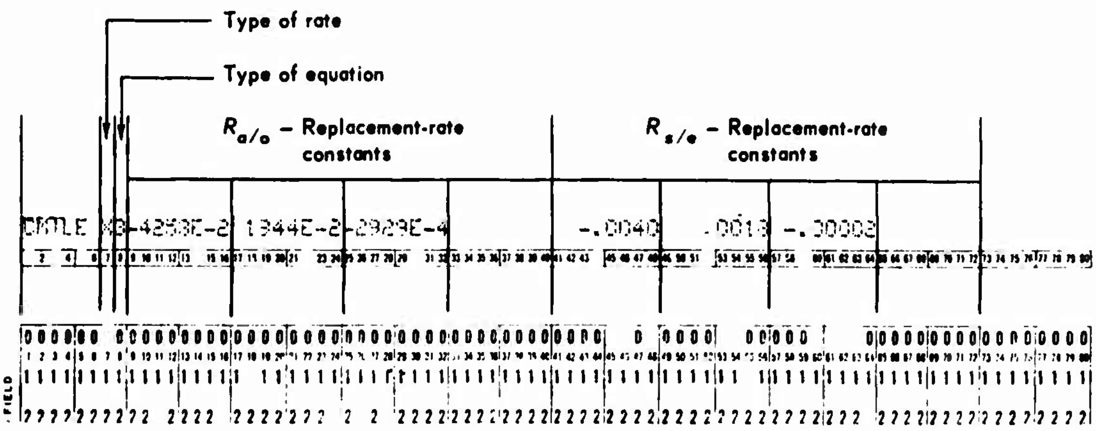


Fig. D11—Format for CONSTANTS Data Cards

Card Deck Setup. The following illustrates how the cards may be assembled for a series of three runs.

Run 1. Two usage measures (months and miles) and two equation types are considered.

Run 2. Same as Run 1 except that the length of the forecast period is changed. This requires a change in USAGE data cards only.

Run 3. Same as Run 1 except that a different forecast period starting date is required and the length of the forecast period is different. This requires a change in DATES and USAGE data cards only. Note that all three data cards of the BASIC group are changed even though the only difference would be on the DATES data card.

Card Setup for the three runs would follow the order below:

```
        BASIC
            FSN
            DATES       (data cards)
            TYPES
        ENDGRP
        USAGE
            UMONTH      (data cards)
            UMILE
        ENDGRP
        EQUIPMENT
            EQPMNT
            EQPMNT
RUN 1         .
              .         (as many data cards as necessary)
              .
            EQPMNT
        ENDGRP
        CONSTANTS
            CMONTH      (data cards for first equation type)
            CMILE
            CMONTH      (data cards for second equation type)
            CMILE
        ENDGRP
        COMPUTE
        USAGE
            UMONTH      (data cards)
RUN 2       UMILE
        ENDGRP
        COMPUTE
        BASIC
            FSN
            DATES
            TYPE
        ENDGRP
RUN 3   USAGE
            UMONTH      (data cards)
            UMILE
        ENDGRP
        COMPUTE
        ENDRUN
```

End Item Usage Routine

This computer program tabulates the number of vehicles in each usage interval of interest. A simplified flow chart of the End Item Usage Routine is presented in Fig. D12.

The user of the program specifies the theater or organizations and the inventory date. The program then selects only the pertinent vehicle data from the equipment history file.

The input to the program consists of certain specification cards that contain the theater and/or organizations requested, the inventory date, the known number of the inventory (so that adjustments can be made for unreported data), the usage measure (months, miles, hours, or rounds), and the basis for the usage interval. The equipment history file is on magnetic tape; it has been prepared from TAERS data.

The program as described is used as a separate program, but it can very easily be made to serve as a subroutine for the Expected Number of Replacement Actions Program.

A more detailed description of the input cards is given in the next section.

Input Data Cards.

THEATER or ORGANIZATION. This card designates the theater and/or organizations that are to be considered when extracting the data from the equipment history file. Provision is made on the card to designate whether a theater or organization is requested, the number of theaters or organizations requested, and their military identification code numbers. This is the very first card read in by the program (Fig. D13).

USAGE. This card contains the usage measure to be considered and the basis for the usage interval. It is placed immediately after the THEATER or ORGANIZATION card.

Any combination of months, miles, hours, and/or rounds may be specified in the usage measure codes field of the card. The desired usage interval basis for each usage measure is punched in the corresponding part of the "Basis for usage interval" field.

The usage measure codes that apply are

Code	Meaning
MO	Months
MI	Miles
HR	Hours
RD	Rounds

Figure D14 illustrates USAGE card format.

DATE. This card designates the date of the inventory and the number of pieces of equipment known to be on hand. When the program extracts the desired records from the equipment history file, a count is kept of the total number of items accumulated in the equipment inventory table being formed. An adjustment is made by the program for unreported data if this total is less than the known number on hand.

This card always follows a special control card that has "ANOTHR" punched in cols 1 to 6 (Fig. D15).

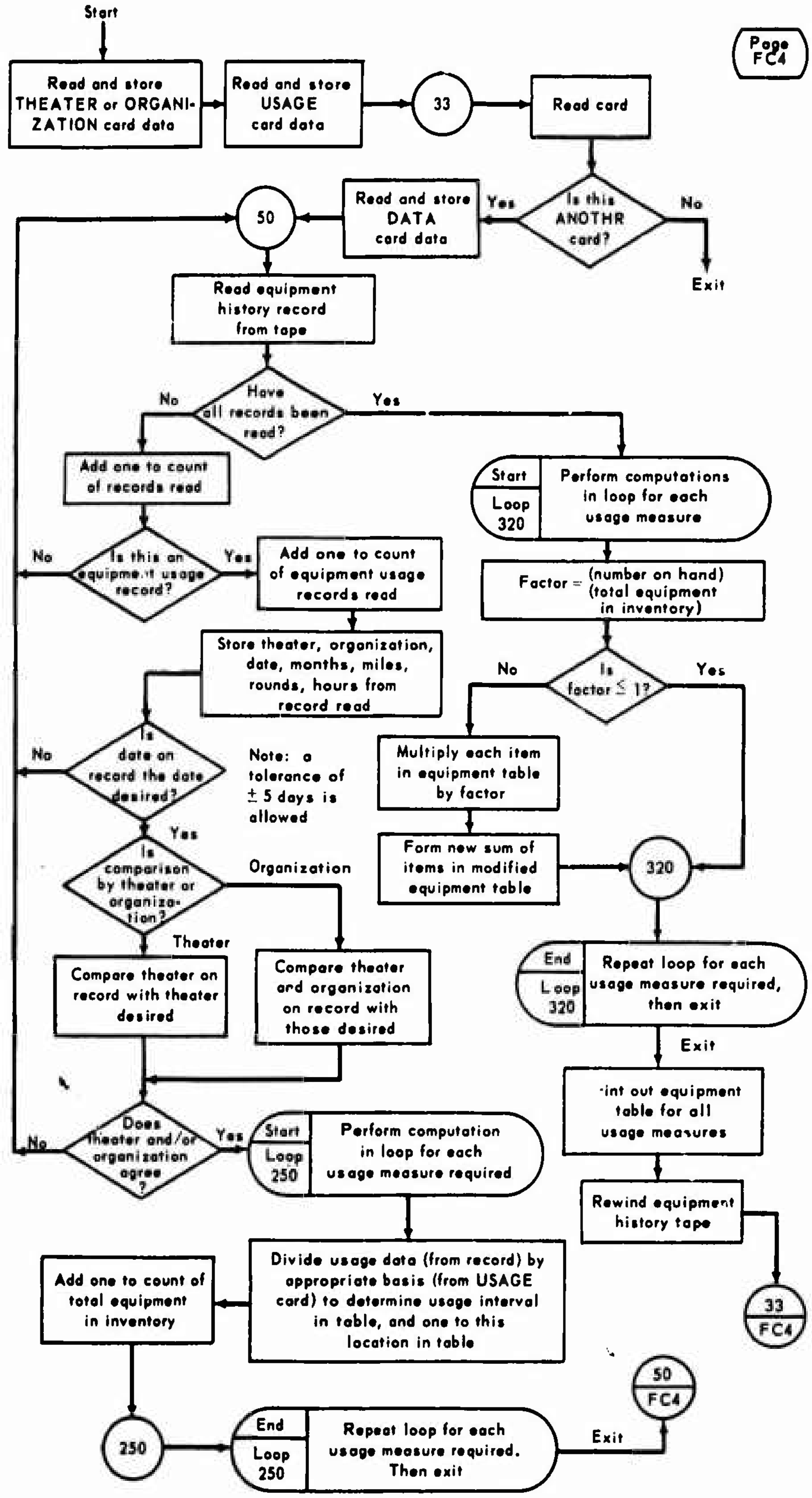


Fig. D12—Flow Chart for End Item Usage Routine

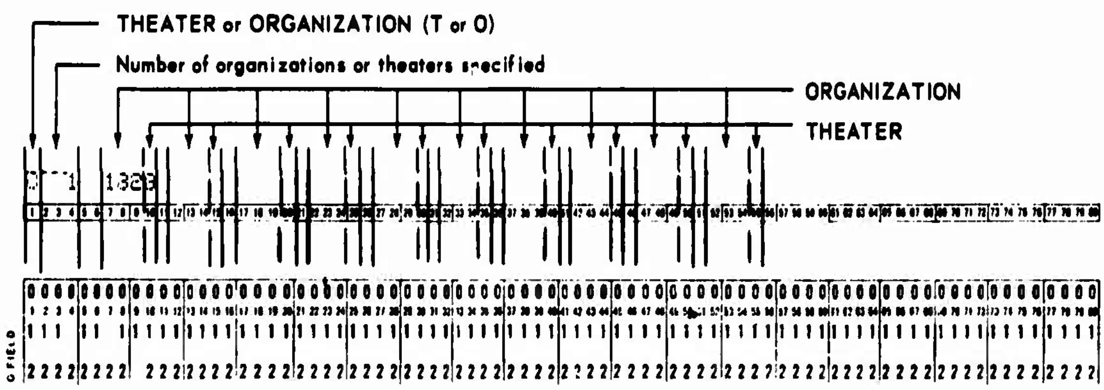


Fig. D13—Format for THEATER or ORGANIZATION Input Data Cards

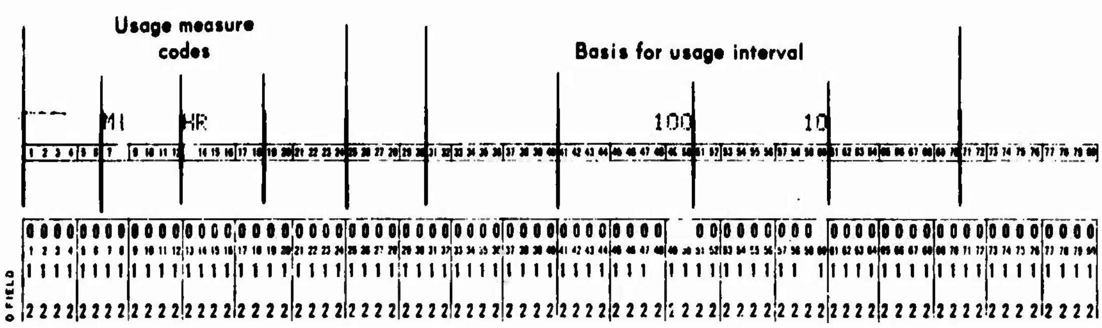


Fig. D14—Format for USAGE Input Data Cards

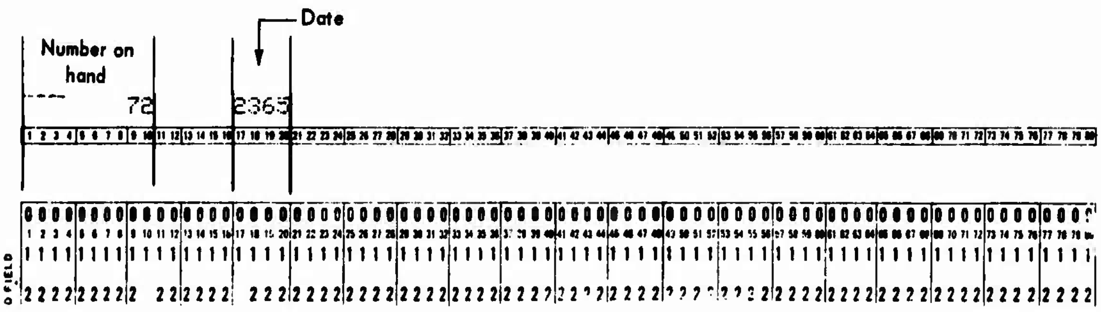


Fig. D15—Format for DATE Data Input Cards

ANOTHR. This card is used in front of the DATE card so that the program recognizes that another DATE card follows. It consists of the word ANOTHR punched in cols 1 to 6. A blank card placed after a DATE card terminates the run (Fig. D16).

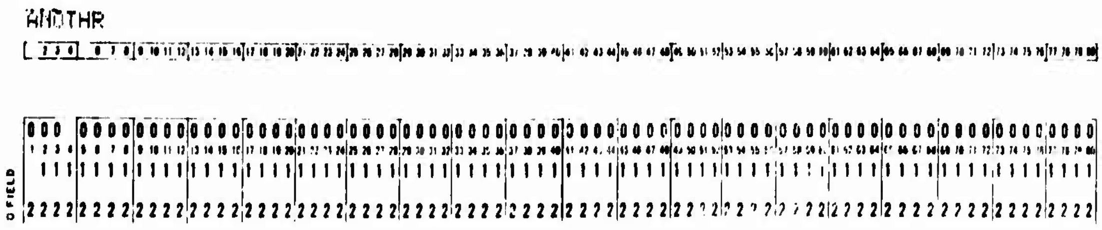


Fig. D16—Format for ANOTHR Data Input Cards

Card Deck Setup. The following illustrates how cards may be assembled for a series of three runs.

RUN 1	THEATER-ORGANIZATION USAGE ANOTHR DATE
RUN 2	ANOTHR DATE
RUN 3	ANOTHR DATE Blank Card

Appendix E

FORECASTS OF USAREUR REPLACEMENT ACTIONS FOR SELECTED M60 AND M113 APC REPAIR PARTS

Tables

This appendix presents forecasts of USAREUR repair-parts consumption (replacement) for 17 M60 tank and 16 M113 APC repair parts listed in App B. These forecasts illustrate the kinds of output obtained from the Expected Number of Actions Program. They also provide projections that can be compared with the reported quantity of parts replaced as soon as TAERS equipment history data have been accumulated for the forecast periods studied. If future evaluations indicate that TAERS data provide an acceptable basis for determining repair-parts requirements, projections of the type presented in this appendix could be a valuable source of information for commodity analysts.

The estimates of repair-parts consumption shown in this appendix are based on USAREUR information[17] that indicates the total number of miles each tank and APC in the active USAREUR fleet had accumulated by 1 July 1964. Forecasts of the quantity of parts that will require replacement during four consecutive quarters beginning 1 January 1965 are provided for three rates of tank-fleet utilization (200, 300, and 400 miles of operation per quarter).

As discussed in Chap. 3, repair-parts forecasts will be affected by the type of replacement-rate equation used in the analysis. This fact is illustrated in Tables E1 to E33, which present a comparison of expected M60 and M113 parts' replacements based on linear and log-log replacement-rate equations. The linear projections are very similar to the log-log estimates. Until a comparison can be made with TAERS data showing actual replacements during these forecast periods, it was felt that no evaluation of these or alternative types of equations should be made.

TABLE E1

Comparison of USAREUR Road and Idler-Wheel-Arm Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter — Type of usage relation					
		200		300		400	
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	42	37	65	58	89	79
2	1965	47	42	76	65	109	93
3	1965	52	44	87	74	130	108
4	1965	57	49	100	83	153	122

TABLE E2

Comparison of USAREUR Battery Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	47	50	71	75	96	102
2	1965	49	52	75	81	102	111
3	1965	50	54	79	86	109	121
4	1965	52	57	82	92	113	130

TABLE E3

Comparison of USAREUR Engine Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relatio					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	103	104	158	159	213	215
2	1965	110	111	171	174	239	243
3	1965	116	118	186	190	261	270
4	1965	123	125	198	205	284	299

TABLE E4

Comparison of USAREUR Generator Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	43	44	65	67	87	90
2	1965	44	46	68	70	93	97
3	1965	46	47	71	75	97	104
4	1965	47	50	73	89	102	112

TABLE E5

Comparison of USAREUR Hub Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	83	77	128	118	175	162
2	1965	92	85	148	137	212	195
3	1965	101	93	170	156	252	228
4	1965	111	102	193	174	295	262

TABLE E6

Comparison of USAREUR Link-Assembly Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	25	25	39	39	52	53
2	1965	27	28	42	43	60	60
3	1965	29	29	48	47	68	68
4	1965	31	31	51	52	75	75

TABLE E7

Comparison of USAREUR Nozzle Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	191	165	294	253	403	345
2	1965	212	180	341	286	487	402
3	1965	232	194	390	317	576	459
4	1965	255	208	441	350	673	516

TABLE E8

Comparison of USAREUR Pump Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	45	38	69	59	93	79
2	1965	48	41	76	63	107	89
3	1965	52	43	83	69	119	97
4	1965	55	46	91	74	131	107

TABLE E9

Comparison of USAREUR Starter-Relay Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	50	35	73	52	96	67
2	1965	46	32	67	42	87	50
3	1965	44	27	64	33	82	37
4	1965	43	23	61	27	77	24

TABLE E 10

Comparison of USAREUR Shock-Absorber Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	89	78	138	121	190	166
2	1965	101	88	166	143	241	205
3	1965	114	98	196	164	299	243
4	1965	127	107	230	186	363	281

TABLE E 11

Comparison of USAREUR Shoe-Assembly Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	36,931	35,846	56,530	55,020	76,882	75,028
2	1965	39,951	39,182	63,314	62,527	88,929	88,375
3	1965	42,962	42,519	70,075	70,035	100,924	101,721
4	1965	45,967	45,856	76,816	77,542	112,876	115,069

TABLE E12

Comparison of USAREUR Sprocket Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	800	721	1235	1112	1694	1524
2	1965	894	803	1450	1298	2085	1854
3	1965	991	886	1682	1483	2519	2183
4	1965	1094	968	1931	1668	2989	2513

TABLE E13

Comparison of USAREUR Starter-Assembly Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	93	92	139	137	184	182
2	1965	91	90	135	133	178	174
3	1965	90	88	132	128	174	165
4	1965	88	86	130	123	170	156

TABLE E14

Comparison of USAREUR Transmission Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	51	43	78	67	107	90
2	1965	56	47	91	74	130	105
3	1965	62	51	105	82	155	118
4	1965	68	54	118	90	182	132

TABLE E15

Comparison of USAREUR Traverse-Gear Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	36	34	54	52	74	70
2	1965	38	36	60	56	84	77
3	1965	40	38	66	60	93	86
4	1965	44	39	71	65	104	93

TABLE E16

Comparison of USAREUR Turbocharger Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	8	8	12	13	16	17
2	1965	8	9	12	12	16	17
3	1965	8	8	12	14	16	18
4	1965	8	9	12	13	17	19

TABLE E17

Comparison of USAREUR Road- and Idler-Wheel Replacement Forecasts for M60 Tank

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	405	397	621	610	846	832
2	1965	441	435	704	697	994	990
3	1965	479	475	787	787	1146	1146
4	1965	515	515	874	874	1300	1303

TABLE E18

Comparison of USAREUR Battery Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	265	230	409	353	559	480
2	1965	294	250	475	397	681	559
3	1965	325	270	547	442	817	638
4	1965	356	289	626	485	964	717

TABLE E19

Comparison of USAREUR Ignition-Coil Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	100	86	153	132	208	178
2	1965	108	92	172	144	243	201
3	1965	117	98	193	156	280	223
4	1965	126	103	213	170	318	246

TABLE E20

Comparison of USAREUR Differential Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	33	31	49	47	66	63
2	1965	33	32	51	48	68	65
3	1965	34	32	52	50	71	67
4	1965	34	33	53	50	72	68

TABLE E21

Comparison of USAREUR Distributor Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	107	105	164	161	223	219
2	1965	116	114	182	179	256	249
3	1965	123	121	202	195	291	281
4	1965	133	128	222	214	327	311

TABLE E22

Comparison of USAREUR Engine Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	86	84	131	128	178	174
2	1965	92	90	147	142	206	199
3	1965	100	96	162	157	235	224
4	1965	106	103	179	170	264	250

TABLE E23

Comparison of USAREUR Track-Pad Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	32,267	31,905	49,319	48,834	66,990	66,414
2	1965	34,723	34,509	54,881	54,690	76,936	76,824
3	1965	37,210	37,110	60,540	60,546	87,096	87,235
4	1965	39,726	39,714	66,282	66,403	97,433	97,645

TABLE E24

Comparison of USAREUR Radiator Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	55	55	83	84	113	114
2	1965	58	59	91	93	126	129
3	1965	61	63	99	101	122	144
4	1965	65	66	88	99	172	159

TABLE E25

Comparison of USAREUR Road-Wheel and Hub-Seal Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	96	93	147	141	199	191
2	1965	103	98	163	156	229	218
3	1965	111	106	180	170	259	242
4	1965	118	112	197	184	289	269

TABLE E26

Comparison of USAREUR Shock-Absorber Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	362	239	563	367	780	501
2	1965	418	262	699	419	1033	593
3	1965	482	285	855	471	1341	686
4	1965	551	308	1037	523	1710	779

TABLE E27

Comparison of USAREUR Track-Shoe Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	41,774	30,841	65,027	47,516	89,970	65,027
2	1965	48,196	34,186	80,248	55,042	118,447	78,407
3	1965	55,305	37,531	97,890	62,568	152,908	91,785
4	1965	63,142	40,876	118,160	70,093	193,995	105,164

TABLE E28

Comparison of USAREUR Spark-Plug Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	1736	1507	2645	2288	3583	3089
2	1965	1847	1582	2894	2458	4021	3390
3	1965	1956	1657	3138	2627	4450	3691
4	1965	2065	1733	3377	2797	4873	3992

TABLE E29

Comparison of USAREUR Sprocket Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	884	605	1382	932	1921	1275
2	1965	1037	670	1747	1080	2610	1540
3	1965	1208	737	2181	1229	3471	1804
4	1965	1402	803	2692	1378	4529	2068

TABLE E30

Comparison of USAREUR Starter Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	221	226	336	343	454	464
2	1965	233	238	363	371	502	513
3	1965	245	250	390	399	547	563
4	1965	257	263	414	427	592	612

TABLE E31

Comparison of USAREUR Transmission Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	51	47	78	72	106	98
2	1965	55	51	89	80	127	112
3	1965	61	54	101	88	149	126
4	1965	66	58	114	96	172	140

TABLE E32

Comparison of USAREUR Idler-Wheel Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	965	802	1497	1223	2065	1658
2	1965	1100	856	1815	1346	2656	1877
3	1965	1247	911	2178	1469	3356	2095
4	1965	1409	966	2587	1592	4171	2315

TABLE E33

Comparison of USAREUR Road-Wheel Replacement Forecasts for M113 APC

(Based on log-log vs linear projections)

Forecast period		Usage rate, miles/quarter					
		200		300		400	
		Type of usage relation					
Quarter	Calendar year	Log-log	Linear	Log-log	Linear	Log-log	Linear
		Expected number of replacements during quarter					
1	1965	637	547	990	841	1366	1149
2	1965	729	602	1204	963	1766	1365
3	1965	828	655	1451	1085	2241	1581
4	1965	938	710	1728	1206	2798	1798

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